Lakes Forest District
P.O. Box 269
Burns Lake,
B.C. V0J 1C0
Attn: K. Van Tune, Silviculture
N. Endacott

Jan. 26, 1989

re: completion of growth and yield installations monitoring
fertilization response - Project: #FN88R01-001, Part 2

This report summarizes the data, maps and methods used in
establishing 4 growth and yield installations in the Lakes District
in Nov./Dec., 1988. Included are copies of raw data of all heights
(including calculations), D3i's, and crown width measurements. I
would be happy to go out in the field this spring to point out all
plots if required, particularly when the Ow Lake area is juvenile
spaced.

As mentioned in the report all raw data has been entered on Lotus
for subsequent data analysis. All file names have been included with
the data discette.

I am still awaiting foliar results from Vancouver before I can
complete Part 1 of this contract. That should happen within 2 weeks
I am told.

Included is my invoice for the growth and yield portion of the
contract (Invoice #2 of 3).

If you have any questions please call:

Sx 89401 R
- 89404 R.

Total Contract =

G 14 established

Keith Van Tune
Burns Lake

-some changes in original contract file
Lakes Forest District
P.O. Box 267
Burns Lake,
B.C. V0J 1E0

Jan. 24, 1989

re: Invoice #2 (of 3) for growth and yield portion of
Project #FN86R01-001

Total work completed: 4 installations @ $4137.50 ....... $16550.00
Expenses: nil (included in above bid price)

Total Invoice .................................................. $16550.00

Thankyou.

[Signature]

Dave Yeats
Box 3942
Smithers, B.C.
V0J 2N0
GROWTH AND YIELD INSTALLATIONS TO MONITOR OPERATIONAL FERTILIZATION RESPONSE IN 4 SITES IN THE BURNS LAKE DISTRICT.

CONTRACT ESTABLISHMENT REPORT

PROJECT # FN88R01-001

D.W. YOLE
BOX 3362,
SMITHERS, B.C.
V0J 2N0

JAN. 26, 1989
Operational fertilization in the Lakes district has become an important intensive silvicultural activity lately with approximately 2800 ha of lodgepole pine stands fertilized during the past 3 years. Spacing and fertilizing of age class 3 P1 stands has been emphasized owing to a probable fall down of wood supply in 40 - 60 years in this district. Older plantations (10 + years) of P1 are also considered high priority for fertilization and are presently being operationally fertilized.

In an attempt to monitor long term growth response (i.e. height, DBH, volume) to operational fertilization, permanent growth and yield type installations were setup in 4 locations in the fall/winter of 1988. Two of the locations, namely, Wisteria and Verdun, were operationally fertilized in the fall of 1988. The installation at Ling Lake was operationally fertilized in the fall of 1987, and the fourth installation at Owl Lake is scheduled for spacing in 1989 with followup fertilization in 1989 or 1990. All 4 locations selected for growth and yield installations were located in areas having a high silviculture priority with respect to present and future investment in juvenile spacing and fertilization.

This report summarizes methods employed, ecosystem information, site maps, and initial data (height, DBH, crown width) collected for each of the four growth and yield installations. Recommendations for future measurements and maintenance of the installations are given.
Each growth and yield installation involves assessment of three treatments including:

- **Treatment 1** - control (unfertilized, unthinned)
- **Treatment 2** - thinned only
- **Treatment 3** - thinned and fertilized

Each of the 3 treatments per installation contains a minimum of 100 sample trees for measurement of response. At all trial locations and treatments, a 15.62 m plot radius was used to define a plot boundary within a given treatment. The term plot also is also referred to as a replicate or rep in these installations. The sample tree closest to the plot center stake was used as the plot center tree and reference point in all cases. Thus for future measurements, the center tree should first be located and then plot boundaries determined from that center tree in order to find all previously tagged sample trees in the plot. At the time of trial installation, center trees were well marked and identifiable from other sample trees by means of multi-coloured flagging tape (lime green, blue, red), having the first number of the plot numbering sequence, and the closest tree to the permanent plot center stake. In case of death of a center tree, the plot boundaries should be referenced to the center stake. The center stake has been spray-painted red on the top of the stake as well as flagged with multiple colours. The treatment identity of each plot can be found by referring to the the label on a 3x3" metal tag nailed to the center plot stake.

For details of plot establishment procedures refer to "Intensive Fertilization Monitoring: Installation Establishment and Measurement" adapted from the Inventory Manual Vol. 2, Chapter 8.21. Where possible suggested guidelines were used except in the case where operational activity or heterogeneous nature of the site limited the size or location a treatment. In general, the number of replicates of a treatment (up to a maximum of 3) at a given site depended on the stand density in order to attain a minimum of 100 sample trees (suggested minimum sample number to make treatment comparisons). Although plot location was random (bearing and distance), precise location may have been adjusted slightly in the field to minimize differences in site features within replicates of a treatment such as ecosystem association, stand density, disease, slope or aspect.

In each plot or replicate of a treatment, all trees were tagged and measured in Nov., 1988 for DBH (DBH tape). Tree height and crown width were measured on either 10 or 25% of the largest, healthy DBH trees. To determine the number of sample trees to measure for top height and crown width, Table 1 was used (see below).

Table 1. Sample Size Table (Growth and Yield Installations).

<table>
<thead>
<tr>
<th>Spacing (m)</th>
<th>NTrees/ha</th>
<th>NTrees for 10 Total Trees/Plot Crown Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>1600</td>
<td>160</td>
</tr>
<tr>
<td>3.0</td>
<td>1100</td>
<td>110</td>
</tr>
<tr>
<td>3.0</td>
<td>800</td>
<td>80</td>
</tr>
<tr>
<td>3.0</td>
<td>400</td>
<td>40</td>
</tr>
</tbody>
</table>
At each site, all replicates within a treatment were located within uniform ecosystem units (landform, soils, vegetation). In addition, plots were located in an area large enough that stand characteristics (spacing density, disease levels) were relatively uniform at the time of trial installation to aid in treatment response comparisons at a later date. For a summary of ecosystem, stand type, and disease characteristics of each installation the reader can refer to Table 2.

Within the age class 2 & 3 installations (Verdun, Ling Lake, Owl Lake) only those trees with a DBH > 5cm were tagged with metal number tags and used as sample trees. At the plantation site (Wisteria), all trees greater than DBH height (1.3m) were tagged as sample trees and measured for DBH. DBH was estimated for any sample tree with DBH < 5cm. Table 3 summarizes the total number of living trees/plot (including regeneration and all tree species greater or less than DBH in height), # sample trees/plot (i.e. number of DBH measurements/plot, all species combined), and the number of top height and crown width measurements/plot for each individual plot within a replicate.

Sample tree numbering in each plot initiated at the plot center tree (near plot center stake) and then proceeds in a north direction towards the plot edge. The numbering then continued in a clockwise direction in and out from the center tree to the plot boundary. Refer to Figure 1 for an example.

Numbered metal tree tags were nailed at DBH on all large sample trees (>5 cm), otherwise metal wires were used to attach tree tags to a branch near DBH height for small sample trees. Orange spray paint was also applied at DBH (1.3 m) for easy identification of all sample trees > 5cm.

Detailed maps of each growth and yield installation are included. All F.O.C.'s, tie points (T.Pt.), and associated bearings and distances to plot centers are marked on maps. Where possible a minimum buffer of 30 m was maintained between plot centers and major openings or roads.

![Diagram](Image)

**Figure 1.** Tree numbering system used in growth and yield trials.
<table>
<thead>
<tr>
<th>INSTALLATION</th>
<th>STAND</th>
<th>TYPE</th>
<th>OPENING</th>
<th>UNIT</th>
<th>ECO-UNIT</th>
<th>SLOPE</th>
<th>ASP. OTHER</th>
<th>FERT</th>
<th>% YR FERT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISTERIA</td>
<td>P1S</td>
<td>110-M</td>
<td>.93E16f-67</td>
<td>103/1988</td>
<td>SBS1/04</td>
<td>5</td>
<td>360 healthy trees; BC -90% live crown (lc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.93E099-532</td>
<td>103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.93E099-541</td>
<td>103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.93E16f-52</td>
<td>103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VERDUN</td>
<td>P1 (S)320-M</td>
<td>.93E16a- (93E90-041)</td>
<td>118/1988</td>
<td>SBSd/07</td>
<td>0</td>
<td>n/a 25-50% stalact. dead fork tops common; 30-50% lc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OWL LAKE</td>
<td>P1</td>
<td>220-P</td>
<td>93K015-13</td>
<td>/89,27</td>
<td>SBSd/01</td>
<td>5</td>
<td>150 30% lc; 10% stalactoforums</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIND LAKE</td>
<td>P1</td>
<td>220-M</td>
<td>.93K5a-23 (93K033-022)</td>
<td>/1797</td>
<td>SBS1/01</td>
<td>0-5</td>
<td>n/a good needle site response to space / fert. 35% lc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# TABLE 3. Summary of tree measurements at each plot for each installation.

<table>
<thead>
<tr>
<th>INSTALLATION</th>
<th>PLOT I.D.</th>
<th>TREE</th>
<th>TOTAL #</th>
<th>FOR DBH</th>
<th>FOR HT</th>
<th>&amp; CROWN</th>
<th>TREE NUMBERS&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING LK.</td>
<td>TREAT1 REP1</td>
<td>530</td>
<td>297</td>
<td>30</td>
<td>1270-150, 1-66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 1</td>
<td>59</td>
<td>59</td>
<td>6</td>
<td>780-1038</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 2</td>
<td>56</td>
<td>56</td>
<td>14</td>
<td>1040-1095</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 1</td>
<td>79</td>
<td>79</td>
<td>8</td>
<td>1100-1177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 2</td>
<td>70</td>
<td>64</td>
<td>7</td>
<td>1201-1265</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WISTERIA</td>
<td>TREAT1 REP1</td>
<td>1007</td>
<td>431</td>
<td>47</td>
<td>250-780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>1  &quot; 2</td>
<td>653</td>
<td>593</td>
<td>69</td>
<td>601-1295</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 1</td>
<td>83</td>
<td>73</td>
<td>7</td>
<td>201-273</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 2</td>
<td>122</td>
<td>108</td>
<td>11</td>
<td>280-387</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 3</td>
<td>151</td>
<td>142</td>
<td>14</td>
<td>1-53, 1401-1458, 601-1293</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OWL LK.</td>
<td>TREAT1 REP1</td>
<td>317</td>
<td>263</td>
<td>26</td>
<td>1401-1456</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 1</td>
<td>320</td>
<td>61</td>
<td>8</td>
<td>855-897</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 2</td>
<td>260</td>
<td>65</td>
<td>8</td>
<td>1-62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 1</td>
<td>462</td>
<td>42</td>
<td>14</td>
<td>901-962</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 2</td>
<td>270</td>
<td>60</td>
<td>6</td>
<td>35-94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VERDUN</td>
<td>TREAT1 REP1</td>
<td>279</td>
<td>251</td>
<td>25</td>
<td>601-831</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 1</td>
<td>82</td>
<td>62</td>
<td>6</td>
<td>15-76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>2  &quot; 2</td>
<td>52</td>
<td>52</td>
<td>13</td>
<td>80-98, 1-33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 1</td>
<td>61</td>
<td>61</td>
<td>6</td>
<td>1-61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3  &quot; 2</td>
<td>47</td>
<td>47</td>
<td>12</td>
<td>65-100, 1-12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Tree numbers missing:  
Ling Lk. treat3 rep2 = 1231;  
Ling Lk. treat3 rep1 = 1107, 1148;  
Owl Lk. treat1 rep1 = 892, 895;  
Owl Lk. treat1 rep1 = 1435, 1376, 1516, 1538;  
Verdun treat1 rep1 = 603, 613, 601;  
Verdun treat2 rep2 = 29;  
Verdun treat3 rep1 = 14;  
Verdun treat3 rep2 = 77;  
Wisteria treat1 rep1 = 577;  
Wisteria treat1 rep2 = 606, 1126, 1231, 1232;  
Wisteria treat2 rep3 = 332;  
Wisteria treat3 rep1 = 1412;
Foliar samples were collected from one location at each installation in November, 1988 as an estimate of current nutrient status of each trial installation area. Foliar nutrient status of each treatment was not a priority of these growth and yield installations, but may be included at a later date. Results of foliar nutrient data of each location can be found by referring to Part 1 of this report (Foliar Sampling and Nutrient Diagnosis of Operational Fertilization Areas in the Lakes District - 1988).

RESULTS

All four trial installations were completed in the period Nov. 1 - Dec. 5, 1988. Metal number tags were nailed to sample trees at DBH and tree numbers are placed so that they point in the direction of the center tree. For each plot, a summary of tree number sequence, missing tree tag numbers, and the number of sample trees measured for DBH and crown width, can be found in Table 3. The plot mean values for top height, DBH, and crown width can be found in Table 4. These mean values are calculated by taking the average of all species combined in each plot. The mean values for individual species can be calculated by first sorting species in the appropriate LOTUS file and then calculating means.

All raw data was entered on LOTUS (discette included) and in addition raw data forms are included as an appendix in this report. To determine the actual tree numbers that were measured for height and crown width in each plot, refer to the computer files under each installation name (or refer to raw data forms). The same individual sample trees measured for height in 1988 should be re-measured in the future.

Ecological forms for each installation site can also be found in the appendices. In all cases the trial areas were located in generally submesic sites dominated by pine. Moisture would be limiting for short to prolonged periods at all sites, depending on seasonal weather.

All POC’s and tie points are clearly marked with 2x2 stakes (spray painted red on top), generally along roadsides, and metal tags attached to each post to provide distance and coordinates to the nearest tie point or installation plot center.

In the case of the Wisteria installation, the 2 control plots were not located in the same block. However these 2 plots are located in similar site and stand conditions for comparative purposes. Of the two control plots, Treatment 1 Rep 2 is located in the same opening (see unit 109) as may be regarded as being most similar to the other treatments due to location. The plot Treatment 2 Rep 3 is located quite close to the fertilized/ non-fertilized boundary (20-30 meters). At the Wisteria installation, all sample trees had blue flagging attached during measurement to avoid confusion and remeasurement of the small dense trees at this trial. Metal number tags were generally hung by metal wire to sample trees near DBH to avoid nail damage. For a few of the larger trees (i.e., greater than 5 cm DBH) tags were nailed to trees.

At the Dul Lake installation, the area has not yet been handplowed. We identified all sample trees with blue flagging, metal number tags, and orange spray paint at DBH. These trees should be left and all unmarked trees in the 4 plots of treatment areas 1 and 2 should be felled. Plot boundaries should be easily identifiable by plot or line over flagging around the plot perimeter.

For detailed maps of each installation and precise plot locations, refer to the figures which follow. Distances and coordinates used to locate plot centers at each installation can be found from these maps.
TABLE 4. Means of DBH, height, and crown width by plot for growth and yield installations - 1988 (all species)

<table>
<thead>
<tr>
<th>INSTALLATION &amp; TREATMENT</th>
<th>DBH (cm)</th>
<th>HEIGHT (m)</th>
<th>CROWN WIDTH (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat 1 rep 1</td>
<td>3.1</td>
<td>4.72</td>
<td>1.05</td>
</tr>
<tr>
<td>Treat 1 rep 2</td>
<td>2.5</td>
<td>3.32</td>
<td>1.64</td>
</tr>
<tr>
<td>Treat 2 rep 1</td>
<td>4.2</td>
<td>3.84</td>
<td>2.04</td>
</tr>
<tr>
<td>Treat 2 rep 2</td>
<td>3.4</td>
<td>3.55</td>
<td>2.10</td>
</tr>
<tr>
<td>Treat 2 rep 3</td>
<td>3.3</td>
<td>3.67</td>
<td>1.87</td>
</tr>
<tr>
<td>Treat 3 rep 1</td>
<td>4.1</td>
<td>4.10</td>
<td>2.14</td>
</tr>
<tr>
<td>Verdun</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat 1 rep 1</td>
<td>10.6</td>
<td>13.5</td>
<td>2.54</td>
</tr>
<tr>
<td>Treat 2 rep 1</td>
<td>15.9</td>
<td>17.0</td>
<td>4.95</td>
</tr>
<tr>
<td>Treat 2 rep 2</td>
<td>15.1</td>
<td>16.2</td>
<td>3.35</td>
</tr>
<tr>
<td>Treat 3 rep 1</td>
<td>15.0</td>
<td>17.7</td>
<td>4.13</td>
</tr>
<tr>
<td>Treat 3 rep 2</td>
<td>17.6</td>
<td>15.5</td>
<td>3.56</td>
</tr>
<tr>
<td>Ling Lake</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat 1 rep 1</td>
<td>11.2</td>
<td>15.1</td>
<td>2.28</td>
</tr>
<tr>
<td>Treat 2 rep 1</td>
<td>16.2</td>
<td>14.7</td>
<td>2.85</td>
</tr>
<tr>
<td>Treat 2 rep 2</td>
<td>12.4</td>
<td>14.2</td>
<td>2.15</td>
</tr>
<tr>
<td>Treat 3 rep 1</td>
<td>16.7</td>
<td>16.2</td>
<td>5.88</td>
</tr>
<tr>
<td>Treat 3 rep 2</td>
<td>17.8</td>
<td>16.2</td>
<td>3.74</td>
</tr>
<tr>
<td>Owl Lake</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treat 1 rep 1</td>
<td>10.9</td>
<td>15.6</td>
<td>2.23</td>
</tr>
<tr>
<td>Treat 2 rep 1</td>
<td>13.5</td>
<td>18.5</td>
<td>2.49</td>
</tr>
<tr>
<td>Treat 2 rep 2</td>
<td>12.7</td>
<td>17.6</td>
<td>1.55</td>
</tr>
<tr>
<td>Treat 3 rep 1</td>
<td>11.5</td>
<td>16.2</td>
<td>1.94</td>
</tr>
<tr>
<td>Treat 3 rep 2</td>
<td>13.4</td>
<td>16.6</td>
<td>2.37</td>
</tr>
</tbody>
</table>
93E N6 (93E094)
Wisteria Growth + Yield

Please refer to revised map March 69

Fertilize 1988

GY Control

Richardson Lake
Wisteria Growth/Yield
Installation 1988

93 E099 - 532
93 E099 - 541

Treatment 1 = Control
replicate 2 = 1/2
replicate 1 = 1/4 50% P1 50% Sx

Treatment 2 = Spaced
3 replicates
note: 2/3 is 60% fertilized with half rate (ie: 218 kg/ha)

Treatment 3 = Spaced and Fertilized

Revised map 1:20,000
March 189

Keith Van
WISTERIA INSTALLATION

Incorrect

103

Please refer to revised map of March 89 - K. Van Tine
Owl Lake G+Y Site
Owl Lake Installation

1.5 km Owl Lake Road

TREATMENT 1
(Control)

TREATMENT 2
(SPACE ONLY)

TREATMENT 3
(SPACE + FERTILIZE)
VERDUN INSTALLATION

TREATMENT 3
(Spaced + Fertilized)

TREATMENT 2
(Space Only)

TREATMENT 1
(Control)

Access Trail

Fire guard

CAT TRACK

2.3 km to Ootsa M/L

Rep 1

Rep 2

Rep 1

Rep 2

Access Trail
Top height, DBH, and crown width remeasurement should occur at 5 year intervals. The sample trees measured in 1986 should again be measured in the fall/winter of 1993. For Ling Lake, Avi Lake, and Verdun sunto and 30 meter tapes are required for height; while 9 meter height poles are preferred for 1993 measurement of the Wisteria trees.

After 2 years, all trials should be maintained, including repainting DBH lines (if necessary), ref flagging POC's and tie points, flagging center trees and center stakes in each plot. Some metal number tags may need replacing after a few years owing to small mammal damage.

During remeasurement, assess for squirrel and rabbit damage in these fertilized areas. Small mammal damage was recorded in all plots in 1986.

Foliar samples could be collected for each plot (and later combined to minimize costs) as an aid in explaining positive or negative growth response(s) to fertilization. At present only one foliar sample per installation was collected to represent the foliar nutrient status of the entire trial area, irrespective of the effect of treatment. Intensive foliar sampling would be particularly valuable in the plantation site at Wisteria since limited fertilization response data is currently available for young, interior pine stands. Foliar samples should be collected at the same time as tree growth measurements.