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SUMMARY REPORT
CLEAR HILLS IRON SAMPLING PROGRAM

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Alberta Research
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Summary Report
Clear Hills Iron Sampling Program

Objective

To obtain a representative bulk sample (150 tons) of the Clear Hills iron deposits for use in beneficiation and smelting tests.

To be representative the sample had to be of *unweathered* material and, therefore, had to be obtained from beneath a substantial cover of overburden, where the iron bed was well back from any weathered surface exposure yet not so deeply buried that removal of the overburden would be impractical.

Sampling Site

The deposit chosen for sampling is the so-called "Swift Creek" deposit, which outcrops along the bank of Rambling (formerly Swift) Creek in Sec. 1, Tp. 91, R. 5, W. 6th Mer. This deposit has been extensively test drilled and contains the largest proven reserves of several deposits found in the Clear Hills region.

The site selected was near to an actual exposure of the iron bed on the west bank of Rambling Creek and also in the midst of closely spaced (1/4 mile) test drilling, these factors together providing excellent geological control. At this location, beneath 50 feet of overburden, the iron bed was known to be about 30 feet thick and to be unweathered except for the uppermost 2 to 3 feet.

Excavation Program

The program called for excavating with bulldozers the 50-foot thickness of clay till overburden to expose the iron bed, followed by trenching to a depth of 30 feet into the bed to secure fresh ore material. The excavation was designed to remain open for future sampling needs, with precautions taken for slope stability, drainage and erosion control.

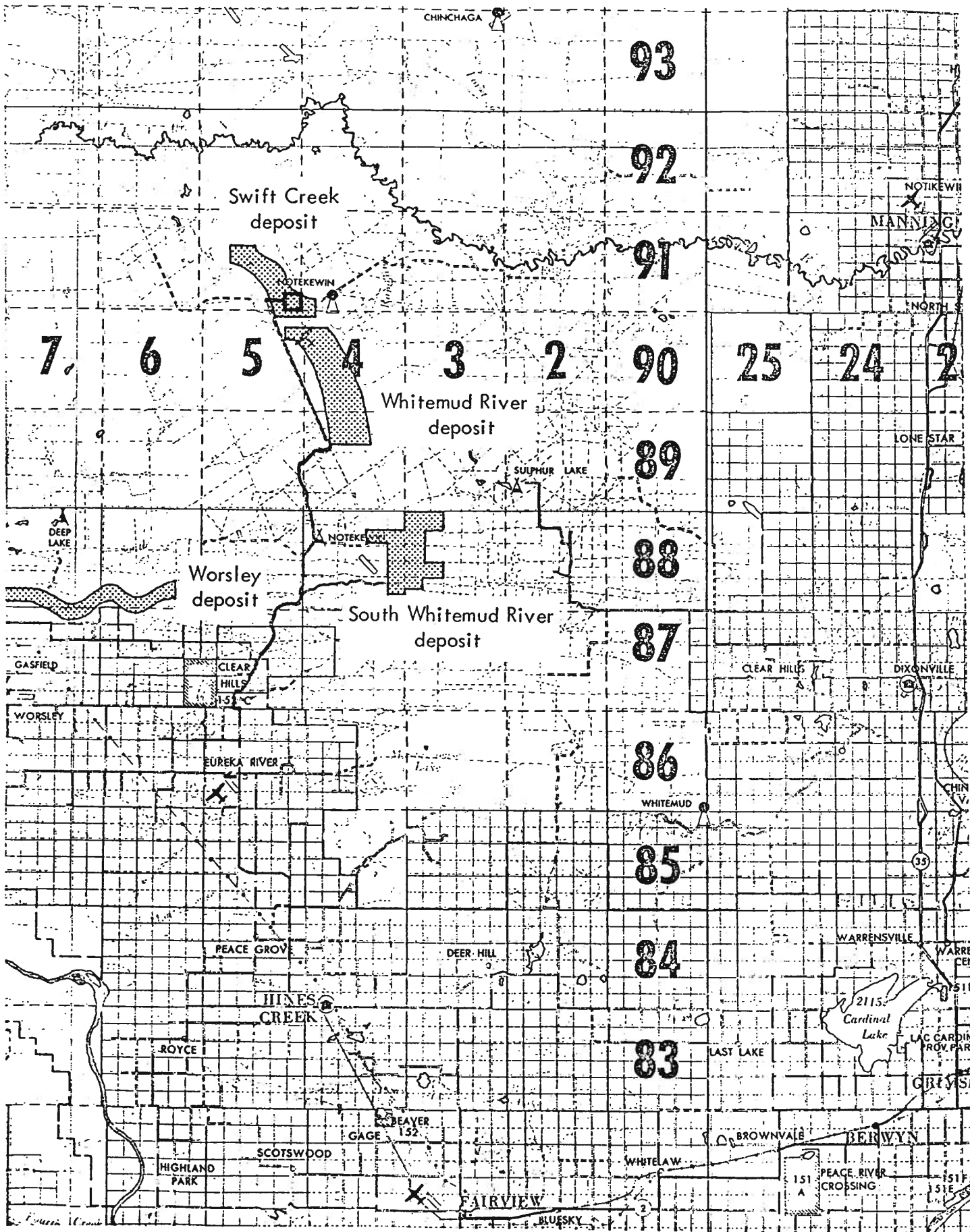


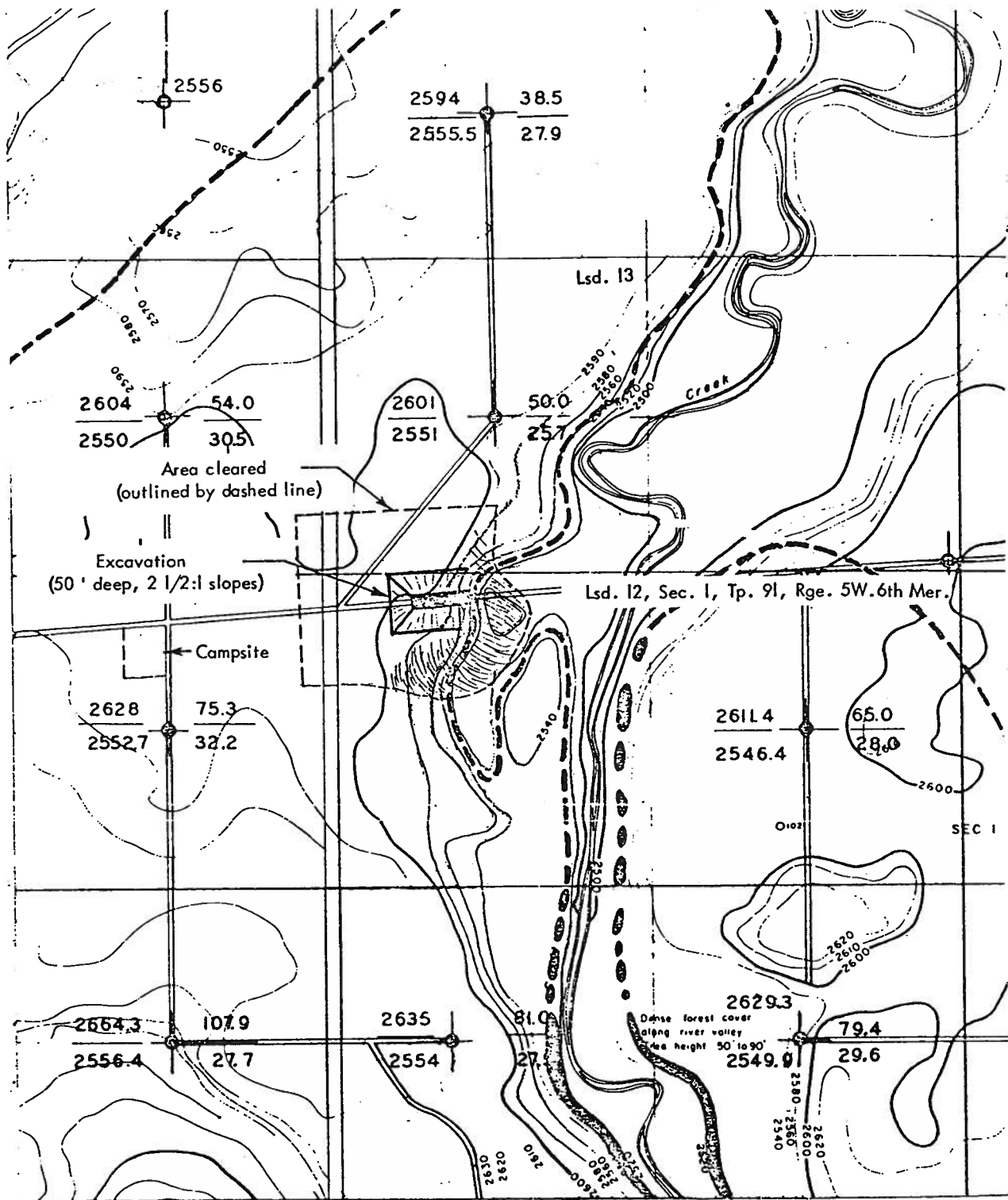
Figure 1. Access map, Clear Hills iron deposits and sampling excavation site on Swift Creek deposit.

Essentially, the project involved clearing an area of about 13 acres and moving more than 100,000 cubic yards of overburden material, then ripping, blasting and dozing up to 3,000 cubic yards of iron ore to obtain the representative samples. The project was begun on February 17, 1974 and completed March 25, 1974 under the supervision of Alberta Research personnel -- W. N. Hamilton and A. Bosman.

Owing to the specialized nature of the project and the critical time factor (a very limited time period allowed in which to complete the work before spring breakup), the excavation contract was awarded by discretionary selection to a contractor known by reputation for over-all proficiency in bush-type operations, particularly in northwestern Alberta. Excellent cooperation from the contractor throughout the project enabled it to be carried efficiently and successfully to completion.

Details of the program are as follows:

1. Access: gained by existing roads and trails north from Eureka River, using the Notikewin forestry tower road for main access, and winter truck trails and seismic lines for final access to the excavation site (Fig. 1). Most of the 30-mile route was open, requiring only 2 miles of new snowplowing plus extra widening on some hills and corners (although several heavy snowfalls during the program necessitated almost continuous snowplowing on the entire route).
2. Clearing of brush and timber: an area of about 13 acres was cleared (Fig. 2). All brush was disposed of and all merchantable timber salvaged to the satisfaction of the local Forest Officer.
3. Excavation of overburden: a volume of more than 100,000 cubic yards was excavated from the pit area outlined in figure 2 using bulldozers (Plate 1A), exposing the iron bed along a strip 40 feet wide for a distance of 200 feet back from its outcrop on the edge of the creek valley. The walls of the excavation were sloped at about a 2.5:1 ratio for permanent stability. Overburden was disposed of in depressional areas



ELEVATION SURFACE (FEET)	OVERBURDEN DEPTH (FEET)
2604	57.0
2596.4	24.4

ELEVATION TOP OF ORE (FEET)	ZONE THICKNESS (FEET)
2601	50.0
2551	25.7
2628	75.3
2552.7	32.2
2664.3	107.9
2556.4	27.7
2635	81.0
2554	27.0
2629.3	79.4
2549.0	29.6
2611.4	65.0
2546.4	28.0

- DRILL HOLE, ORE ZONE PRESENT.
- DRILL HOLE, ORE ZONE ABSENT.
- EROSIONAL EDGE OF ORE ZONE.
- OUTCROP " " "
- == ACCESS TRAILS

Figure 2. Plan of sampling excavation on Swift Creek iron deposit.

along the edge of the creek valley and was sloped off gently to the valley bottom. A buffer strip 25 feet or more in width was left between the toe of the spill pile and the trees, and a zone of undisturbed vegetation was maintained for a distance greater than 400 feet back from the bank of Rambling Creek. No "piling up" of overburden spill was required.

4. Sampling of the iron ore: with the excavation of overburden completed and the walls properly backsloped, trenching of the exposed iron bed was undertaken in the manner indicated in figure 3, initially by ripping the iron bed with ripper teeth mounted on the rear of bulldozers and then dozing the loosened material up out of the pit for sampling (Plate 1B,C). The samples were taken at 1-foot intervals by successive ripping and dozing, and were proportioned equally into the sample containers -- 45 gallon steel drums -- set out in batches of up to 25 (Plate 1D), such that each drum of a batch, when filled, would contain representative material from a 5-foot interval of the bed. As each batch of drums was filled the drums were sealed, and a new batch was deployed for the next sample interval. As the pit was deepened the surplus iron ore was stockpiled -- to be used subsequently for backfilling.

This method of sampling continued to a depth of 11 feet into the iron bed, the rock becoming harder and more difficult to rip with each foot. At the 11-foot depth ripping became ineffective, so that to penetrate the remainder of the iron bed it was necessary to resort to blasting (Plate 1E,F). The blasting was conducted in 4-foot sections, and samples were collected for the whole 4-foot interval after each blast. This changing of the sampling interval from 5 feet to 4 feet was necessary because the blasting crew, which had been mobilized on short notice, only had 4-foot steel for the rock drills; accordingly, the number of barrels to a batch was reduced proportionately. Details regarding the blasting program (drill hole patterns, charge size, etc.) are given in figure 4.

In the fourth round of blasting -- a penetration of 16 feet further into the iron bed -- the base of the bed was intersected, to give a net thickness of 27 feet for the iron deposit at this locality.

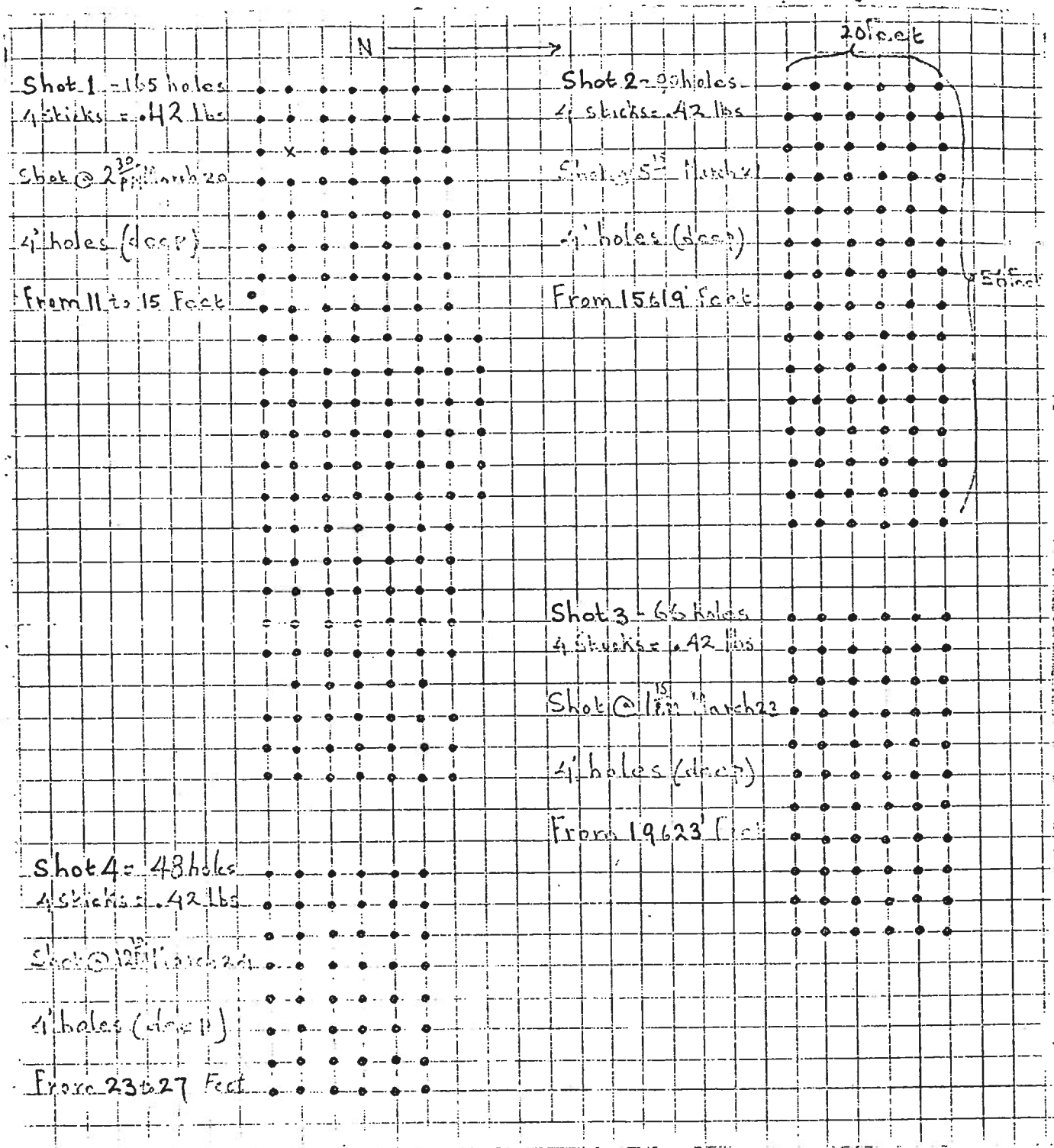


Figure 4. Drill hole patterns for blasting.

The sample intervals and number of barrels are as follows, each barrel of ore weighing approximately 700 pounds:

<u>Depth Interval</u> (from top of iron bed)	<u>Number of Barrels</u>
0'-5'	25 (#10-#25)
5'-10'	25 (#26-#50)
10'-15'	25 (#51-#75)
15'-19'	22 (#76-#93, #97-#100)
19'-23'	21 (#94-#96, #101-#115, #123-#125)
23'-27'	21 (#116-#122, #126-#139)
Total	139 barrels
Total weight 96,000 lbs (48 tons approx.)	

With the iron bed fully exposed an additional 6 barrels of hand-picked samples were obtained directly from the face of the bed by the representative of a German consulting firm engaged to study the ore. Finally, a bulk sample of approximately 100 tons was taken from the surplus ore stockpile in several truckloads -- for the private use of the iron property leaseholder.

5. Reclamation of site: all reclamation efforts were approved by the local Forest Officer. To stabilize slopes and avoid possible soil erosion problems, the excavation walls and spill piles (previously backsloped to a ratio of 2.5:1 or greater) were seeded with a mixture of Kentucky Blue Grass, Red Fescue, and sweet clover applied at a rate in excess of 50 pounds per acre. A drainage barrier was constructed around the perimeter of the site to divert surface runoff into the adjacent forested area, the barrier consisting of a low ridge of overburden material built up to a height of 2 to 3 feet above the general land surface. The iron sampling trench was left open temporarily -- subsequently to be backfilled with stockpiled surplus ore when the

licence of occupation expires (February, 1976) or when no further need for sampling is foreseen. As the trench is to be backfilled, no drainage provisions were made at this stage. The walls of the trench are near-vertical to a depth of 27 feet at the deepest point, but are formed of competent rock and present no stability problems. Neither do the steep walls present any undue hazard to wildlife, for they are clearly visible from anywhere on the excavation slopes above, the slopes become more gentle near the walls (almost flat above one), and the trench walls also are bevelled back slightly along the upper edges -- sufficient to give ample warning of the steep drop. Both ends of the trench, sloped to a gentle grade for sampling access, allow easy entrance or exit to animals.

Checks will be made on the effectiveness of reclamation measures and corrections applied if and where necessary.

6. Equipment: four D8 Caterpillar bulldozers with ripping capability were used for the overburden excavation, two of these subsequently for the iron ore mining as well (Plate 1A,B); these proved to be the minimum requirement, and for certain stages of the program additional or heavier equipment could have been used advantageously (e.g., scrapers for the overburden stripping, a D9 for the iron ore trenching). A wide track D6 was used for snowplowing and road maintenance. The blasting equipment included a Gardiner-Denver compressor powering three hand-operated percussion drills simultaneously (Plate 1E); the explosive was Geogel 60%, a high velocity (20,000 fps) explosive that proved overpowerful for the rock conditions, causing more shattering and throwing out of the material than was desirable.
7. Campsite: an area 150 feet square was cleared about one-quarter mile west of the workings (Fig. 2) and a trailer camp set up to house as many as 20 people -- including two shifts of work crews, foremen,

attendants, and Alberta Research personnel. Camp waste disposal and cleanup of the site were approved by the Forest Officer.

8. Costs: the project incurred a total cost of approximately \$115,000, considerably greater than the original estimate of \$65,000. This higher cost is attributed to two main factors: the tough, plastic state of the clay till overburden, which took much longer to excavate than would normally be expected; and the unforeseen hardness of the iron formation, resulting in an extra large expenditure on the actual trenching and sampling, both in ripping and, subsequently, blasting costs. A breakdown of costs is given below.

1. Snowplowing access, preparing trail, and maintenance (catwork)	\$ 11,860
2. Moving equipment and camp	13,500
3. Clearing brush and salvage of timber, grass seeding and cleanup (catwork and labor)	6,720
4. Overburden removal (catwork)	45,540
5. Iron ore recovery (catwork and labor)	10,140
6. Blasting and drilling	7,230
7. Camp rental and subsistence	5,990
8. Hauling of ore barrels	2,300
9. Supervision and vehicle - contractor	6,000
10. Shipping of ore barrels (air freight to Germany)	2,540
11. General project expenses (helicopter reconn., barrels manufacture, etc.)	<u>3,000</u>
TOTAL	\$114,820

Note: these figures do not include Alberta Research salaries

Description of Overburden

The overburden thickness of 50 feet on the iron formation consists throughout of glacial till -- mainly dark bluish grey clay with relatively few boulders.

and pebbles -- forming a densely compacted mass of tough, sticky, stiff plastic material from top to bottom. Only the lower 10 feet showed any indication of being different, slightly less plastic, but otherwise much the same as material above.

Boulders and pebbles, sparsely scattered in the clay, comprise an assortment of rock types: quartzite, granite, some sandstone, and rare limestone. Rare pebbles and boulders of the iron formation also can be found in the interval just above the iron bed for a few feet. At the base of the till section a thin (4 inch) band of light olive green clay, distinctly different from the clay above, forms a sharply defined marker on the top of the iron bed. Rare pebbles of the iron formation also occur in this clay.

The dense, tough, plastic nature of the clay till made it difficult for the bulldozers to excavate. The dozer blade could take only a very thin cut with each pass, the material rolling up in a giant slice before the blade, and if dug in only slightly deeper the machine would be stalled abruptly. Attempts to loosen the material by ripping proved rather futile, the ripper tooth doing little more than carve a sharp, narrow groove into the clay. Consequently, excavation of the clay proceeded rather more slowly than expected.

Description of Iron Deposit

No detailed lithologic description of the iron formation was made on the site, the lithology and petrology having been thoroughly described by others from cores taken nearby. Further petrological studies are planned for in the laboratory; thus, field observations were focussed mainly on gross lithologic and structural aspects of this sedimentary unit.

The iron formation for the most part is massive, showing only vaguely defined stratification within its upper and lower boundaries. The unit is

topped by a highly oxidized zone generally less than 6 inches thick, consisting of earthy, very crumbly, rust-colored material, which rests upon comparatively hard, slabby, oxidized oolitic iron-rich sandstone extending over an interval of 2 1/2 feet. The sandstone, reddish brown in color, containing conspicuous rounded pebbles of greenish clayey material, is fairly friable and brittle; it rips with ease, coming up in large slabs which can be broken readily, and upon exposure to air for several hours smaller pieces of the material begin to disintegrate. The bottom foot of this interval records a transition from the thoroughly oxidized material above to essentially unoxidized material of identical rock type below. Within this foot, the color varies from reddish to greenish brown, with a characteristic submetallic (almost iridescent) finish on fracture cleavage surfaces in the rock, presumably caused by "sweating" of the iron.

Below this 2 1/2-foot oxidized interval the oolitic iron-rich sandstone becomes distinctly dark green, almost black in color. For the next 2 feet the material remains somewhat friable and brittle and rips fairly easily, but from here downward it becomes increasingly harder, more dense, and more difficult to rip. Moreover, in this interval the formation lacks any well developed bedding separation planes or horizontal cleavage to facilitate ripping. It becomes effectively impenetrable by the ripping method at a depth of 11 feet below its top.

To the depth of about 11 feet, the iron formation retains a rather dull, granular appearance, with the oolitic texture very evident on broken surfaces, but below this the rock becomes more uniformly hard within its textural framework and tends to break across the oolite grains rather than around them, giving a subconchoidal aspect to fracture surfaces. The rock remains still fairly brittle, taking on a somewhat shiny appearance. From here to the base of the bed at 27 feet the rock shows little change in gross physical characteristics, notwithstanding a known petrological change, in



A



D



B



E



C



F

Plate 1. Clear Hills iron excavation program.

which the oolite content declines gradually from about 60 percent near the middle of the bed (and throughout the upper half) to about 20 percent at the base, with a concomitant increase in the content of the mudstone matrix and decrease in the ferruginous cement. One noticeable change, however, is the earthy appearance that the rock acquires in the lower 5 feet or so, reflecting the increased mudstone content (to about 50 percent at the base). With blasting, the rock responded more or less to the same degree of fragmentation for each interval blasted.

The base of the iron formation is marked by a change from the dark green to black oolitic iron-rich mudstone to a medium to dark bluish grey clay. The contact is fairly sharp, but forms an irregular surface.

The iron bed is virtually flat-lying and undisturbed, no warping or faulting being apparent within the trench dimensions. However, two distinct sets of joint planes are developed, one set striking at an average of N50°W and the other N60°E, both dipping vertically. No well developed horizontal cleavage is apparent except in the uppermost 3 feet or so.

Report on Clear Hills Iron Ore Sampling Site

Site is located in Lsd 12, 13, Sec. 1, Tp. 91, Rge. 5 W. 6th Mer., on west bank of Rambling Creek in Clear Hills area, northwestern Alberta, where major excavation and iron ore sampling program carried out in March, 1974. Inspection of the site made on September 20, 1974 to determine effectiveness of reclamation measures taken on completion of program. Following is a summary of observations:

1. General condition of site appeared excellent from air and from ground. Both excavation and campsite left tidy, with all waste and debris diligently disposed of.
2. Cleared area surrounding excavation has revegetated itself naturally with grasses and mosses. Seeding on excavation walls has yielded generally good growth for first season — best on upper portion of slopes, but tending to be spotty in places on lower parts; should fill in nicely with another season's growth. Only grasses are growing — clover apparently did not germinate.

Recommend another inspection in fall '75 or spring '76 and reseedling of any bare patches remaining.

3. Erosion effects on slopes have been minimal despite heavy rainfall during summer, without protective vegetation cover. Run-off tended to spread out evenly over slopes (rather than funnel into a few main water courses), so that of the myriad of tiny gullies formed, few are more than 1 or 2 inches deep.
4. Water from surface run-off has collected in pit to maximum depth of 13 feet. No hazard to wildlife — gentle approaches at either end of pool allow easy access to and from water. No foreseeable need for pit dewatering.
5. Slight amount of drainage into pit from cleared muskeg area directly back of excavation — not significant (only a gentle trickle), could be corrected if subsequently indicated to be potentially more serious problem.

2.

6. Heavy rainfall has caused saturation of much of overburden spill and settling of piles by as much as 4 feet (as indicated from occasional protruding tree stumps). Although no actual slumping observed, downward creep evident on slope surfaces on parts of overbank spill, has inhibited establishment of grass cover. These parts may require reseeding once spill has stabilized.
7. On shoulder just above northeast end of pit, the excavation and overbank spill are not properly backsloped and the spill (water saturated) is tending to slump, held back by edge of surplus iron ore stockpile. When backfilling of pit with surplus ore is undertaken, this part of excavation should be backsloped and reseeded.
8. Salvaged timber stacked on southwest corner of clearing not yet claimed — beginning to deteriorate.
9. Noted that little use can be made of surplus iron ore stockpile for future bulk sampling. Only about one-third of total 5000 tons could be recovered without contamination, and this material not entirely representative of ore body. Additional sampling best done from south face of exposed ore bed, by sideways blasting of small section of bed into pit.

W.N. Hamilton
Alberta Research Council
September 24, 1974