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CHRISTCHURCH NEW ZEALAND

Harvest System Options for Western Springs Pines

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Contents

1 Goal

Overall goal – To develop an appropriate harvest plan that supports the objectives of the Waitemata local board of; protecting existing and future ecology and regaining access to Western Springs forest reserve, ensuring compliance with Environmental and Health and Safety obligations.

Western Springs reserve has been closed to the public since 2018 due to an elevated risk of pine trees falling in the wind/rain. Multiple arborists' expert opinions on the current condition of trees and future risk of failure have been presented. Concerns raised in the reports include the stand being in a state of 'active failure', posing a risk to reserve users and individual trees being hazards to nearby properties. Commonly accepted risk management strategies call for elimination or minimisation of risks (in order of preference).

The removal operation is consented by Auckland Council following a challenge in the Environment Court.

There is a need to develop an appropriate felling and extraction ('harvest') plan that meets the many physical, but more importantly - ecological and social objectives of the operation. For some stakeholders a loss of aesthetic values has been highlighted as an issue stemming from pine tree removal. With removal however, there will be a long term gain in aesthetic value with significant opportunity for the community to help and influence the recovery of a thriving native forest. Direct impacts on understorey flora and fauna from the felling and extraction operation have also been highlighted. A 'no-impact' removal is not practicable if taking into account the wider impacts on neighbouring properties/residents and safety of personnel carrying out the work. In the long term, removal of the pines will benefit flora and fauna by the elimination of pine-litter on the forest floor and improved light to the (current) understorey vegetation.

The operation(s) proposed are similar to a commercial tree harvest, but on a significantly smaller scale. As such, guidance for operating standards can be found in the National Environmental Standards for Plantation Forestry (NES-PF), and more specifically the Environmental Code of Practice for Plantation Forestry (ECoP), and Approved Code of Practice for Safety and Health in Forest Operations (ACoP).

Outcome: develop a pragmatic, safe and feasible harvest plan for the successful removal of the pine overstorey, while minimising any substantial impact to the understory vegetation.

2 Harvest Plan Options

2.1 Considerations

- The plan should keep earthworks to a minimum, and any tracks installed should be re-contoured to slope upon completion of the operation (see Figure 6, page 10).
- Vegetation disturbance should be kept to a minimum. This requires that the contracted 'crew' are not under production pressure by the contract manager, with a strong emphasis on minimisation of damage to existing understory vegetation.
- The ecological areas identified should be respected, however without some level of machine access, more of the felled material will be left on site, impeding native restoration efforts.
- Three Options have been put forward and are considered, being (a) the removal of all (/most) the trees, (b) the removal of approximately 50 trees that present a risk to the existing walking track, and (c) the more permanent closure of the site for research / preservation purposes (whereby individual trees near the boundary that present a risk to neighbouring would still need to be removed).
- Many of the pine trees are now in a condition where climbing for removal in segments is limited without using adjacent trees or crane-like structures for support. As such, the most practicable method is to fell whole trees directly to the ground.
- The vast majority of the pine trees are 'mature' with limited crown diameters. While they are large trees, they will have a limited footprint on the ground. Simply felling the trees as a whole should have no greater impact that an arboriculture contractor removing individual trees in segments.
- Trees should be felled towards planned tracks to minimise extraction disturbance. Note that in commercial forest operations trees are typically felled away from the track, so the trees can be pulled out butt-first (stump end forward) to minimise stem breakage. In this case we are not concerned with stem breakage during extraction.
- Some of the pine trees are leaning (heavily) towards boundaries. Individual trees that present a hazard beyond the boundary will need to be taken down in sections by arborists.
- Depending on the extraction option chosen, the material onsite should be cut up into 6m segments (adjust to log export specifications to minimise waste), with the additional processing completed in the Western Springs yard by the access track on the Eastern site.

2.2 Harvest Plan

The following figures detail the proposed harvest plan, with reasons for the specific options in the text to follow. Note that all these plans have been prepared and provided in A3 format also. Figure 1 shows the felling zones map with slopes (Appendix III), in what are considered standardised slope categories for forest operations. The green and light green colours are readily trafficable by forestry equipment, the yellow/green is easily accessed by tracks, and light orange areas should only be worked on with caution and is restricted to machines just moving up and down the slope. Orange exceeds the limits under normal operating conditions, and blue is so steep that it is an identified hazard. It also shows the existing trees, and the proposed three felling zones that reflect the steps in the removal process (see Section 2.5 for more detail).

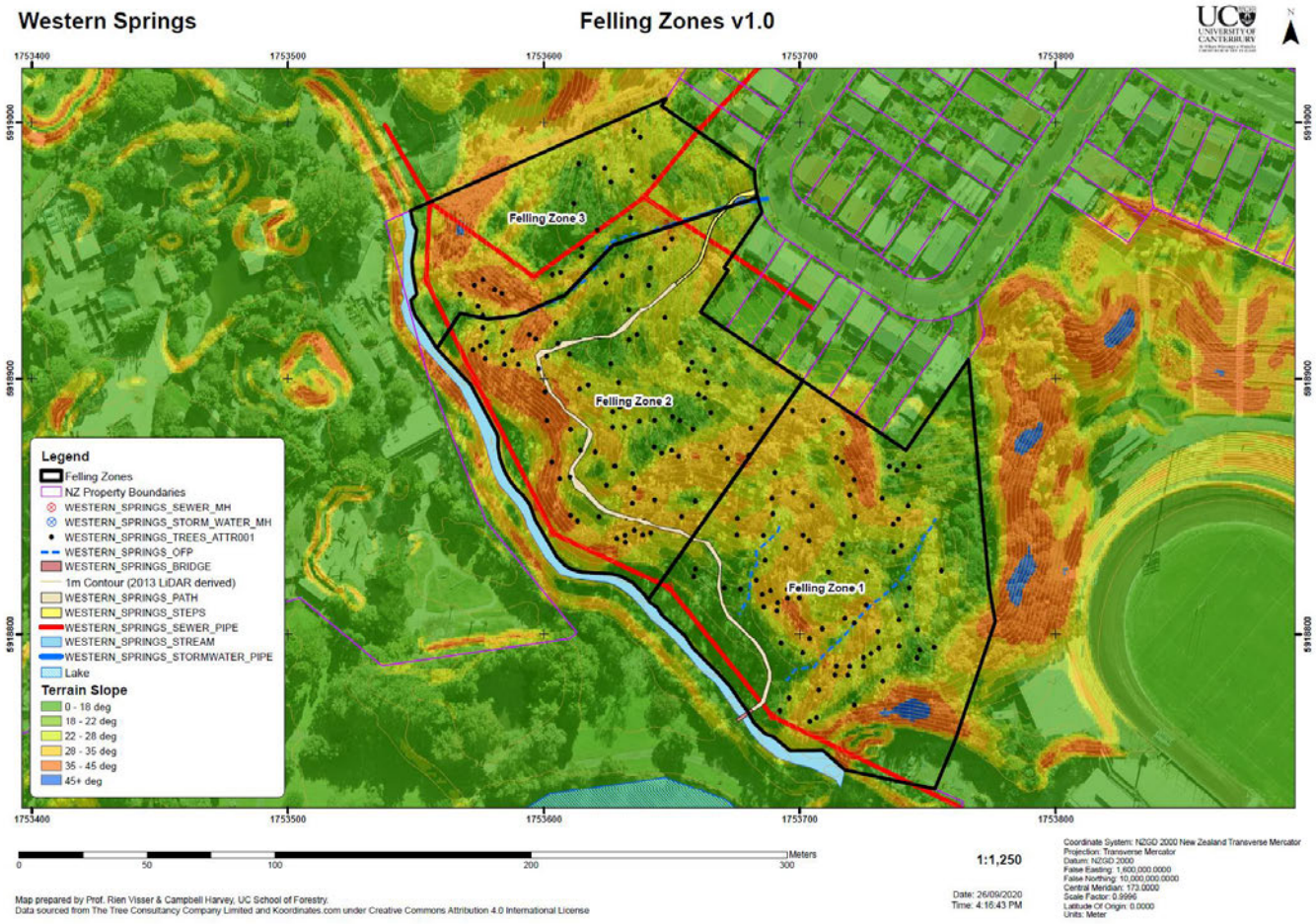

Figure 1: A map showing the terrain slope as classified for forest operations (note A3 version in Appendix III).

Figure 2 shows the output from RoadEng (a software programme for planning tracks/roads); specifically the proposed track location (also in A3 format as Appendix IV). Note that plans have been prepared for two tracking options: (v1) the lower impact track with regard to soil disturbance and best fit for the extraction plan, and (v2) a track that stays higher on the slope but thereby avoids the PAP3 and PAP4. A small spur track has been designed that would provide ready access to the top of Zone 1 (design shown in Appendix V), but that may not be required depending on contractor capability. A small track has also been designed to access Zone 3 (design shown in Appendix VI), but the Consented 'Plan E' (as prepared by Ridley Dunphy - see 2.3) shows this to be a machine restricted area. If that restriction remains, trees can be felled and left.

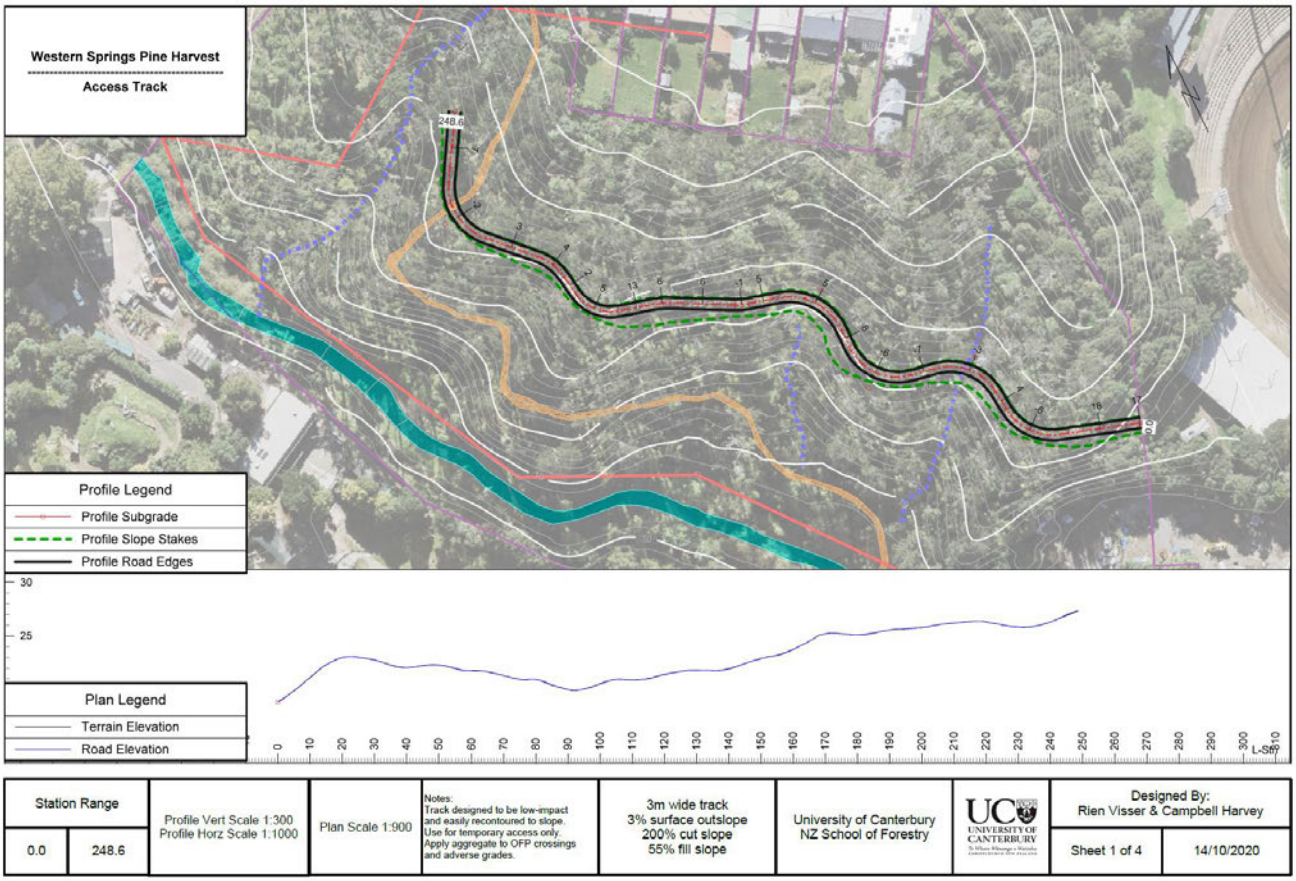

Figure 2: The proposed track (Version 2) that remains a little higher on the slope to provide the best possible protection for PAP3 and PAP4.

While track V1 creates the lowest level of soil disturbance as it minims the tracking across the mid-slopes, V2 track is chosen as the preferred harvest plan option for the removal of all the trees ('a') because it better respects the PAP3 and PAP4 Zones (see PAPs in Figure 5) that are on the lower slopes. For the removal of only the risk trees near the track ('b'), the track presented as v1 might still be a preferred as this track will be closer to those trees, will have a lower level of traffic / activity and hence a lower impact on PAP3.

The more complete harvest plan is shown in Figure 3, whereby contours, processing areas, tracks (v2), felling zones and felling direction are all shown. Such a plan is typically the operational plan for a contractor, and for the Council to monitor compliance. Note that the infrastructure shown on this Harvest plan is substantially less than the Ridley Dunphy plan for which the Consent was obtained, as such no new Consent should need to be sought.

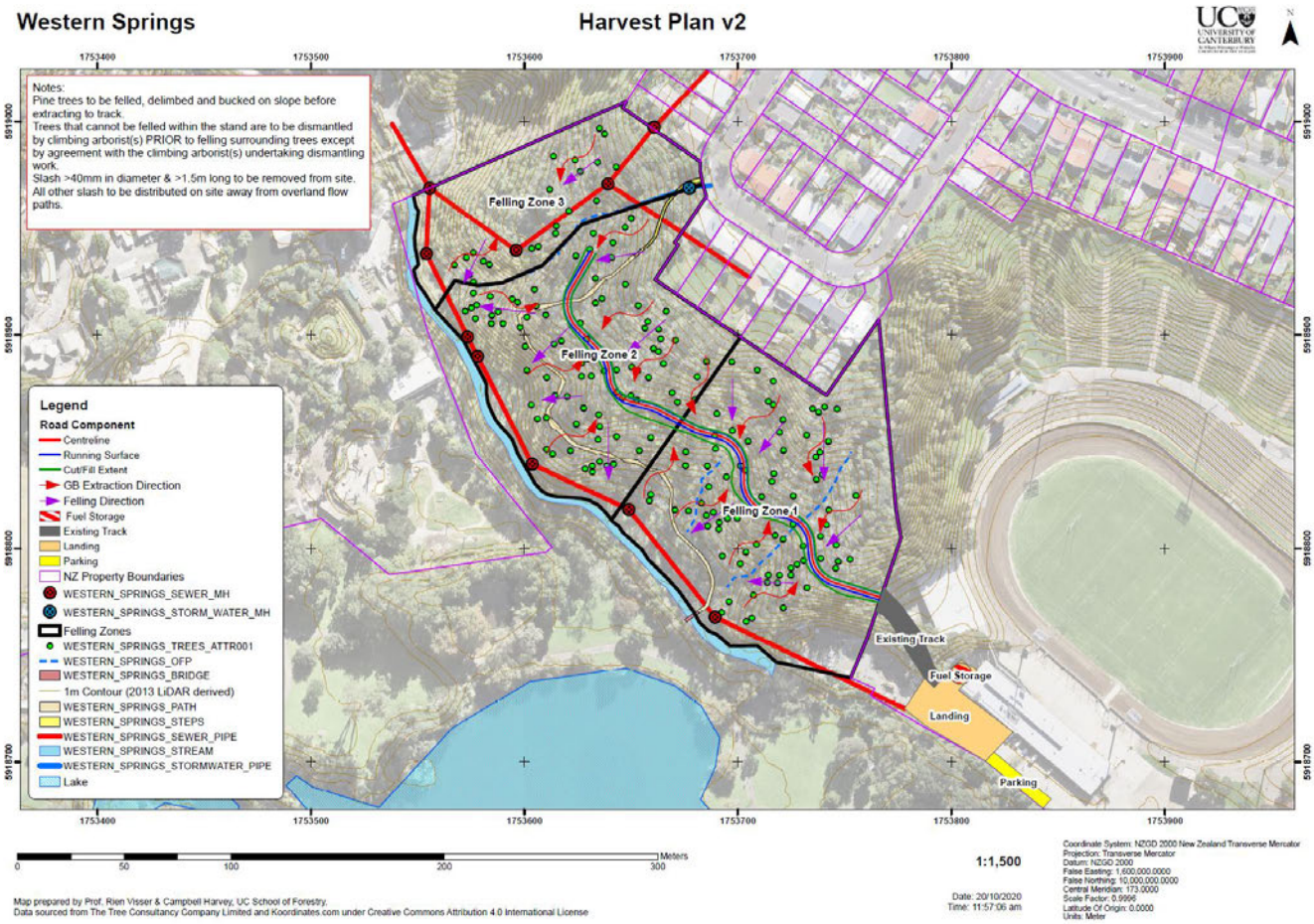

Figure 3: The 'Harvest Plan' showing contours, processing areas ('Landing'), tracks, felling zones and felling direction, as well as infrastructure hazards (sewer & stormwater).

2.3 Comment on Existing Plan & Consent Conditions

Ridley Dunphy have produced several harvest plans. We have considered the Ridley Dunphy's Plan, Revisions A and E (Resource Consent #: LUC60321424) in helping to develop this harvest plan.

The plans prepared are very detailed, but given consideration now of the specific felling and extraction requirements, they present a level of earthworks that is not required for an efficient operation. The plan revisions A & E also detail a drainage control design that would either have to be maintained in perpetuity, or would involve a substantial amount of work to recover back to a more natural environment. If there is an intent and or benefit of retaining the planned access road for future use, then such work may be warranted. Even if the infrastructure is planned to be permanent, the plans might be considered excessive in terms of number of processing sites by forest engineering standards in a commercial forestry scenario. However, this is a moot point with regard to existing Consent as the new plan does not pull the trees from the forest, nor does it process in the forest. As shown in Figure 3 (Appendix II), further processing and temporary storage of the material removed from the forest is at the back of the speedway ('Landing').

The following comments provided on the existing Plans are only for the purpose of showing the logic of progression to arrive at a final plan aligned with the current objectives.

Comments on Plan A (shown in Figure 4): Given the height of the trees, the number of trees and the distances involved, the construction of three larger landings would be excessive. Installing culverts to cross the overland flow paths requires some disturbance of the beds, forcing them to either to be dug down, or the track(s) built up with imported materials (aggregates). The construction of settlement ponds requires the drainage pattern to be concentrated on the landings. Settlement ponds need to be large enough to function adequately, and as such they require considerable soil disturbance also. The introduction of geotextiles in the drainage path on the far right (western) drainage is unnecessary. Geotextiles are great for stabilizing the ground under roadways, however with all machinery access excluded from the area, installing and later removing geotextiles could do more harm than good to the immediate environment.

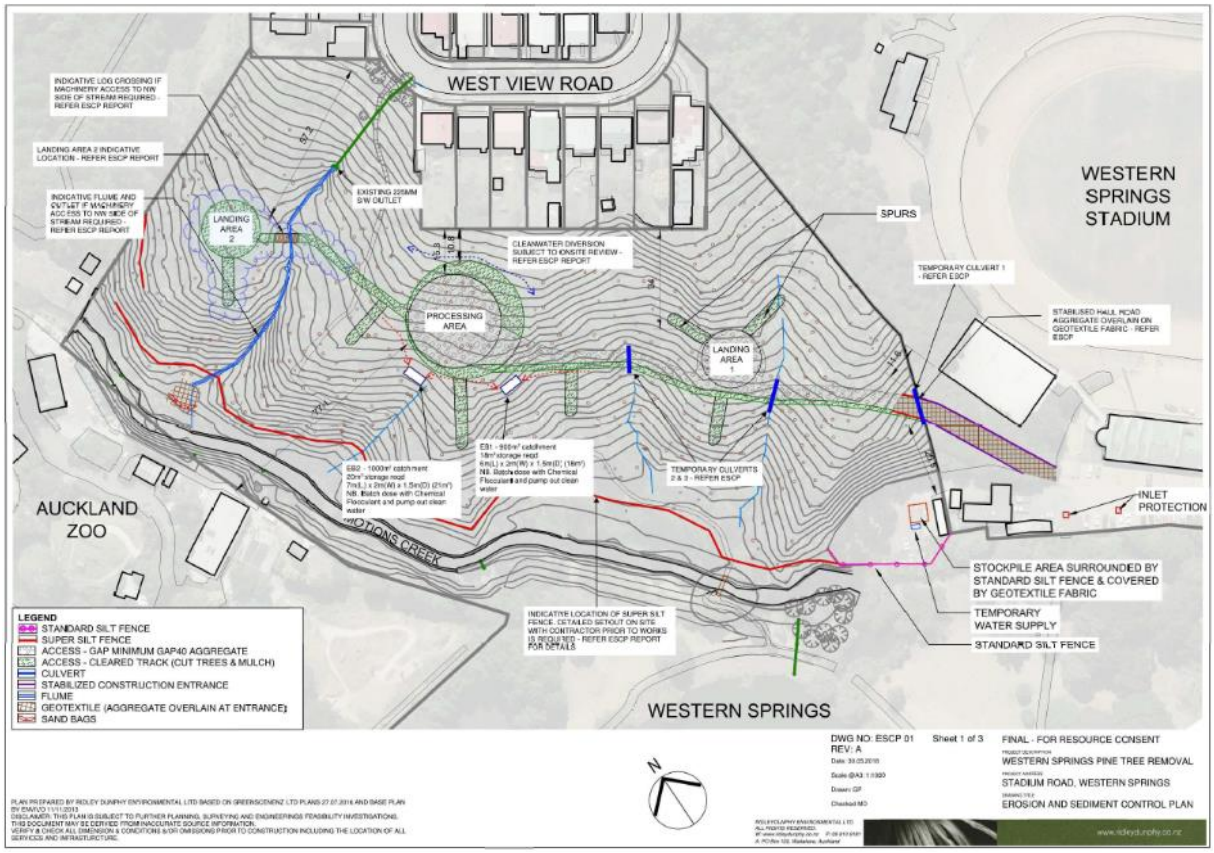

Figure 4: Site Plan, Revision A.

Comments on Plan E (shown in Figure 5): Revision E (the final version used in the successful Consent application) shows an updated version of the infrastructure as well as the identified ecological areas (PAP's). While the road alignment in Revision E is more sympathetic to the contours of the terrain, the short stretch of track between the access gate and the first skid site is too steep without significant earthworks to reduce the grade. The remaining sections of track are planned at an easy grade.

The five processing areas shown might be considered excessive as they are literally only a tree length apart. While the landing areas and track are shown on the plan, no account has been given to the

extent of cut or fill batters – therefore the true extent of the associated vegetation loss is unknown. The removal of the sediment ponds and the addition of runoff-filtering slash bunds is positive in reducing impact on the site.

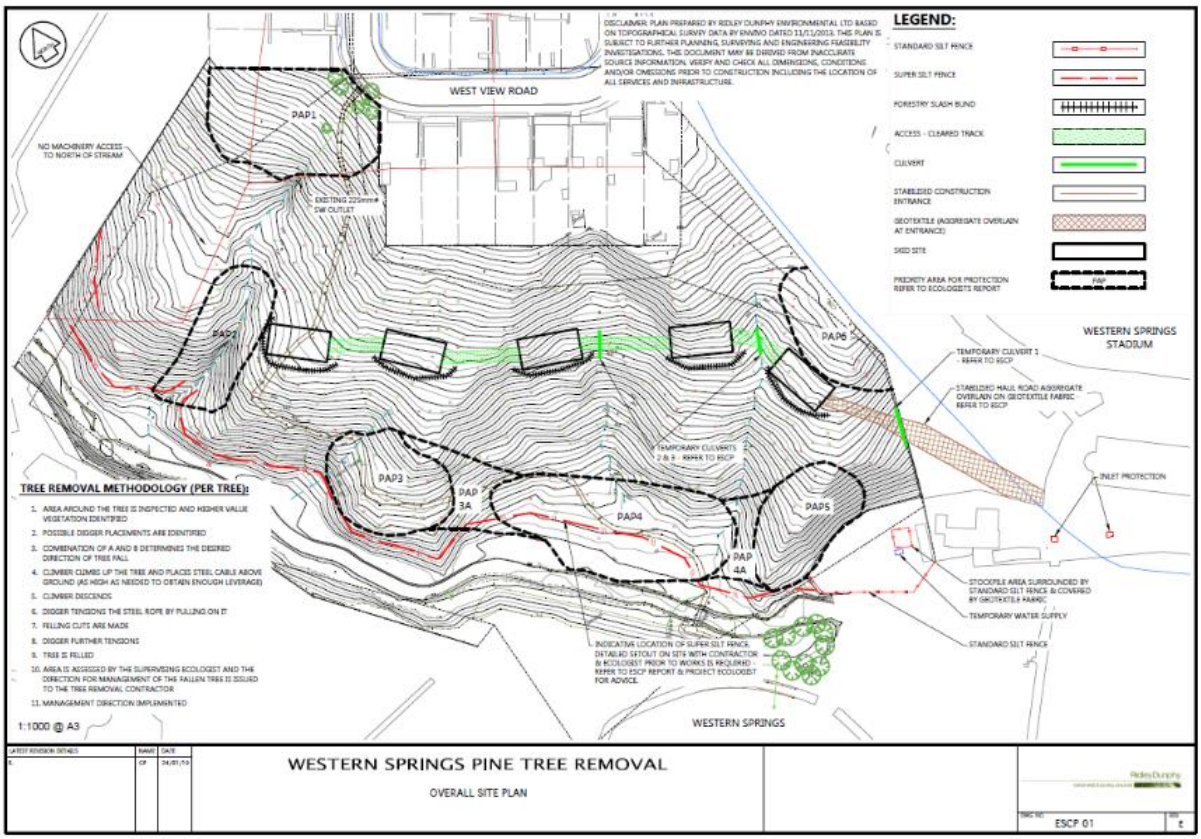

Figure 5: Site Plan, Revision E. It is understood that this plan is the final consented plan as per Resource Consent condition 38, but subject to change following a site walkover with the Society's expert ecologist.

Consent Conditions

The number of conditions present on the consent document is assumed to be commensurate with the sensitivity of the receiving environment, flora, fauna and social impacts. Two conditions are of note in regards to their feasibility.

38A. Updated Geotechnical Report

It is noted that the Council is to receive an updated geotechnical report which takes into account the finalised specification for works. We note that the Geoconsult report (dated 03/06/2016) specifies cut and fill batter angles that are *impossible to achieve* on many parts of this site, with a secondary plan of installing retaining walls. It is our opinion that in order to complete the objective with minimal disruption, earthworks should be completed to a 'temporary' standard, allowing straightforward decommissioning. Accepting steeper batter angles as a temporary construction measure to enable short-term access should be seriously considered. Reducing the width of the road corridor will also result in less vegetation disturbance, also in alignment with the overall goal.

45. Roads and Footpaths

The interpretation of this condition is important. *Earthworks activities* are proposed to use a balanced cut/fill technique which does not require 'end-hauling' excess fill to the staging area. This means no soil should be intentionally moved beyond the stand boundary. If interpretation includes the non-intentional deposition from track and wheel movement during the *extraction activity,* applying the rule (literally) may be detrimental to the extraction operation. The design of the machinery proposed and nature of their use will loosen and move some soil. Soil can be cleaned from the staging area periodically or prior to completion, but 'immediately' as stated may be considered quite unnecessary.

2.4 Detail for Extraction Track(s)

The objective is to design and construct an extraction track that will facilitate the removal of the felled material with minimal soil disturbance (cut and fill). The maximum grade of the tracks should be no greater than 20% to ensure they are both easy to traverse, and that minimal erosion should occur during rainfall. The secondary objective is to enable easy recontouring of the track after the operations are successfully completed. Recontouring refers to the retrieval the sidecast soil (typically the top-soil) back over the formation to return the site to its normal 'shape' (see Figure 6).This mitigates the longer term effect of soil disturbance and compaction. Recontoured tracks will typically green up within 3-6 months, and will barely be visible after 12 months with the return of vegetation.

Figure 6: Example of a recontoured extraction track in a production forestry scenario. Note that full length trees were pulled along this track prior to recontouring.

The proposed harvest plan presented in this report is to construct a primary track approximately 230m long, and 3m wide, which differs little from Ridley Dunphy's Revision E. This is only wide enough for a small, articulated vehicle and the excavator. With 200+ trees on site at an estimated 5 tonnes each, it is expected that the track will be used to extract approximately 1000 tonnes of woody material. Depending on the size of the extraction machine, a typical payload will be 6-8 tonnes, as such we can

deduce that approximately 140 machine passes will occur on the track (of course, 140 passes along the start of the track, diminishing to very few passes near the end of the track).

Two additional sections of track are designed and only to be used if desired and or required (referred to as East and West extension options). There is also an opportunity to construct an additional 'East' extension track (approx. 80m long) to access the trees nearest properties 14-18 West View Road (East end, see Appendix V), however the preference is to 'shovel' (move downed trees with the excavator) these Eastern trees to the primary track to minimise soil disturbance.

Felling Zone 3 has been labelled as a no-machine on the Ridley Dunphy plan (Figure 5). Assuming this status remains, the trees felled on that far western side will need to remain in situ. However, if the excavator is allowed to encroach on the area it could shovel the stem segments back to the end of the track, or, as shown in Appendix VI, a 90m extension of the primary extraction track can be installed using of an easy crossing point on the western-most overland flow path (see Appendix VI) to facilitate the removal of the material.

This proposed tracking plan eliminates the need to construct landings/skid sites/processing areas in the forest. The intention is to delimb and buck the trees where they fall and/or on the access track(s) before moving logs to a staging area on the chip-sealed yard for loading onto road-trucks. This will significantly reduce the total volume of soil disturbance compared to the previously proposed plan, ensuring the earthworks plan is feasible, minimalistic and presents the lowest possible risk of disturbed soil leaving the site and or entering the waterway.

The soil appears strong (Geoconsult report 2016 – 'mantel of typically firm to very stiff strength residual soils) and the introduction of material (i.e. aggregates) will only be required on the track segments where the soil is weak / wet, and or on an adverse grade.

The introduction of plastics (such as geotextile materials) should be avoided wherever possible as the materials do not decompose and compete with the natural character of the forest. Suitable substitutes to geotextiles may be slash bunds (material available and generated on site) or woodchip. Use of hydro-seed should be considered with the knowledge that introducing vigorous grasses may necessitate regular intervention post-harvest to ensure native seedling survival.

Figure 7: Visualisation of the proposed temporary track alignment(s), including the two extension options.

2.5 Equipment

2.5.1 Felling

Mechanised felling is normally preferred for safety and productivity in production forestry. In this case, from a feasibility perspective; the trees are very large in diameter, beyond the capabilities of most purpose-built tree felling heads. Therefore there is limited opportunity for mechanised felling. From an environmental effects perspective, machine access to each tree for felling will also do considerable damage to the understorey, a key constraint. As such, chainsaw felling to bring the trees to the ground is required. Approximately 80% of all trees can be readily felled in one piece with a chainsaw. With a predominant lean of the stand downhill, this is advantageous for both felling and extraction. There will be an impact to the understory vegetation where the tree falls, and again when the machine accesses the tree for removal. Again a primary goal is to minimise vegetation disturbance through good directional felling practice, and minimise overall disturbance from an effective harvest plan. Damaged vegetation can be expected to recover in a 6-12 month period.

Note that the faller should have their advanced felling qualification(s) that includes leaning trees. Felling should be towards the extraction tracks where possible to reduce effort required to extract the wood. The bole / stem of the tree should then be bucked to specification, whereby a 6m length will help facilitate extraction.

Following felling, the faller will need to delimb each tree, which refers to cutting off the larger branches and breaking down the canopy of the tree to facilitate removal. To mitigate further damage to the understorey vegetation, no trees should be pulled through the forest with branches still attached.

An excavator with grapple will need to be on-site. The primary purpose will be the ‘shovel’ the stem segments towards the tracks and if required load the ‘dumper’. Note that ‘shovelling’ simply refers to picking up and moving the wood, instead of dragging it along the ground (‘skidding’). The excavator may also be used to support directional felling for either safety reasons, or to help direct the trees to an area that will maximise the protection of understory vegetation. This may be required on only 10% of the trees (see Section 2.5.3).

Felling and extraction operations should be de-phased from each other, meaning each operation is completely separate. The tree faller(s) should have no concerns about targets within the fall-radius. Further explanation about tree-falling practice can be found in the ACoP.

2.5.2 Track Construction (& Recontouring)

Track construction will necessitate the use of a 15-20 tonne earthmoving excavator. Borelogs attached to the geotechnical report by Geoconsult show silt to depths greater than the proposed cut therefore it is anticipated a rock bucket will not be necessary. If the machine is to manipulate felled stems or work near the standing trees, forestry guarding is required on the machine for operator safety. Specifically for the recontouring works; a tilting bucket is ideal for retrieving soil and also for the final shaping.

2.5.3 Extraction

Two machines will be needed to extract the felled material (note: this assumes that most/all of the material felled will be removed). Exceptions can and should be expected for the edge trees where machine access will cause unnecessary damage. For these cases a professional arborist should be engaged to remove the tree.

1. A slope-capable (i.e. self-levelling preferred) grapple excavator with forestry guarding (see Figure 8) with a skilled operator should be used. Such a machine can access much of the site and shovel the felled tree sections to the track. This excavator can be used to assist felling by directing trees to fell in the desired direction, load the forwarder on the track in the forest and also load the road truck at the staging area (with ground surface protection – long track grousers will otherwise damage the pavement surface).

Figure 8: Typical forestry excavator (non-self-levelling) with grapple on a 'high and wide' carrier.

2. A small tracker ‘dumper’ or a forwarder. While a forestry forwarder is a possibility and may be more readily available, a useful option could also be a small and robust moxy-type tracked ‘dump-truck’ that can unload itself in the staging area (see Figure 9). The small dump-truck type machine may be more versatile by being able to cart both the stem segments and the larger slash (small woody debris), but a forwarder can also carry larger slash segment (i.e. branches longer than 2m). Forestry forwarders cannot carry smaller slash and therefore its removal would require another solution.

Figure 9: An example of a forwarder shown on the left, and the tracked ‘dumper’ on the right.

Note that all branches >40mm in diameter and >1.5m long should be removed along with the logs. Removal will very much improve the aesthetics of the finished site, and also reduce fire risk.

Note that such machinery is normally delivered to the site on a ‘low-boy’ transporter.

2.6 Timing of Removal

2.6.1 Selective Tree Removal

This is effectively an ‘arboriculture’ option, where each tree is taken to the ground in sections. It would require many months to complete and be done at great expense, at no small risk to tree workers.

Advantage:

- Priority for removal can be given to the most at-risk trees first.
- Transition from pine dominated stand to native overstorey over a longer timeframe.

Disadvantage:

- The park would not open for access until all at risk trees are removed.
- Almost annual impact (for 10+ years?) to both the soil and the understorey as individual trees are removed. Machine access would have to be gained for each operation.
- Without a material removal strategy an excessive volume of timber will remain on the ground taking many years to decompose (see Figure 10). While this may be acceptable for a few locations, leaving all 200 trees will have a major visual and ecological impact.

Figure 10: Remnants of a tree brought to the ground in segments.

2.6.2 Patch Removal

This strategy gives the opportunity to identify and fell groups of trees (say 15-20 typically) that are deemed to be the highest risk, creating one clearing at a time. Option 'b' is effectively a form of an extended patch removal.

Advantage:

- This may utilise a more commercial (lower cost, lower risk, lower impact) system to fell and extract the felled trees as presented in this harvest plan.
- A more timely and orderly removal as compared to the selective tree removal option.

Disadvantage:

- Need to design infrastructure to reach each patch, and at every entry there is further soil and native vegetation disturbance.
- Because the at-risk trees are not readily grouped for patch removal, the reserve is still unlikely to open under this scenario as many at-risk trees will remain.
- By removing patches there is also an increased risk of windfall. New edge trees will be exposed to wind, and that wind can readily funnel into the patches - unless they are well enclosed in the remaining stand, but the stand is not large enough to accommodate such a strategy. A wind direction frequency plot for five Auckland sites can be found in Appendix VII.

2.6.3 Removal of All Pine Trees

Note the following is the preferred option. It minimises the overall impact and best achieves the desired objectives. It is the removal of all the Pine trees. The felling and removal would proceed in three 'zones' (see the Felling Zones map, Appendix III), whereby these zones are logical blocks (1, 2 and 3) allowing for sufficient work time to extract/load out each area and also ensure worker safety from the overhead hazard of the standing trees in the successive felling zone(s). There is a strong preference to complete the felling and extraction in these zones sequentially, as it best meets the overall objective. However, the three stage removal can be separated over weeks/months/years ('staged'), but that would incur similar disadvantages as the 'patch removal option presented in 2.6.2.

Advantage:

- Complete removal of all pine trees.
- Expedites opening of whole reserve when completed sequentially.
- Minimises overall disturbance by avoiding repeat entry to complete work.
- Removal in three zones will help minimise immediate aesthetic impact – pine overstorey will remain visible and taper off as the work proceeds.
- No substantial impact on fauna if works are completed in accordance with Resource Consent conditions.

Disadvantage:

- More sudden aesthetic impact compared to single or patch removal.
- More concentrated impact (in terms of time) to native flora during falling and extraction, even if the overall impact over time is lower.

3 Scheduling of Works

The following information is provided to be indicative only. Actual progress of works will very much depend on the resources any contractor(s) will bring to the site and the weather conditions encountered during operations.

1. *Survey in the track(s).*

A simple survey to delineate the centreline of the track is all that is required for this operation. This could be completed by a 2-man field crew with a high accuracy GPS within a single day. Markings (such as flagging tape or spray paint) will need to be elevated on vegetation and highly visible to machine operators as trees will be felled to/over the planned track corridor prior to construction.

2. *Fell Zone 1 (including dismantling difficult edge trees).*

The felling of zones is to enable a smooth transition from pine forest to regenerating native and to allow logical sequencing of works. A further benefit is the safety of workers outside of machines; bucking, delimbing and attaching chokers to extract felled trees. The zone boundaries can be subject to change by the onsite assessment of the contractor(s). Due to the expected increase of wind pressure on edge trees, difficult edge trees that are hazards to neighbouring properties will need to be dismantled either prior to the rest of the felling, or concurrent with the operation.

Felling each zone is expected to take 3-5 days.

3. *Buck and clear track corridor.*

Trees felled over the planned track(s) need to be cleared off the corridor prior to the track being built. This will require the grapple excavator and chainsaw operator. Felling prior to construction allows for greater safety as the excavator will not be working underneath and/or destabilising standing trees. Timber should be cut into three products depending on dimensions, defects and available markets. Timber should be bucked into lengths that satisfies that different markets available for the products

to minimise waste and handling. Note that there is little real value in the wood products in this stand and selling them will do little to offset the cost of the operation.

Clearing the track corridors in Zone 1 is expected to take 2-3 days.

4. Build track.

Constructing the track sections in Zone 1 should be completed within 3 days. The track is to be a basic formation only using balanced cut and fill technique.

5. Extract – load the truck with excavator and dump in staging area.

Extracting timber will be subject to significant variation depending on the quality of the felling, vegetation protection, extraction techniques adopted by the contractor(s), the machines used and the weather conditions encountered. Making a broad assumption about the expected work rate under normal conditions, this operation is expected to take 4-5 days for Zone 1. Regardless of work rate, it is important that the contractor(s) are not placed under production pressure to ensure soil and vegetation protection remains the highest priority.

6. Load out piles.

Loading out the piles of export timber, firewood and chip/slash again will be subject to variation that is difficult to predict. Assuming that 1/3 of the trees will produce approximately 300 tonnes of various products, this operation may take up to 4 days depending on truck availability, scheduling and load rates.

7. Inspect track and site condition.

Supervision of the operation should be ongoing (i.e. weekly would be appropriate) and include ensuring that the track remains in good condition. Any damage or excessive disturbance should be rectified in a timely manner to avoid an environmental or safety risk. A more formal inspection (i.e. with short report including photos) should be completed after Zone 1 (and then again Zone 2) is felled and extracted. This would be an appropriate point to intervene if the plan is not meeting disturbance expectations.

8. Repeat Works 2-6 for Zones 2 and 3 in sequence.

All three operations, if completed sequentially should be completed within 8-10 working weeks – assuming no prolonged periods of wet weather.

9. Recontour track(s) to slope.

Recontouring tracks is a straightforward task for an experienced earthmoving operator. Assuming all tracks (as proposed) are installed, the recontouring operation is expected to take 2 days.

4 Additional Considerations

4.1 NES-PF

The NES-PF is an instrument enabled by the Resource Management Act (1991) that presides over District and Regional Plans. The NES-PF was brought into effect to provide consistency in forestry planning standards across the many districts and regions throughout New Zealand. Within it, standards can be found for harvesting, earthworks, quarrying, stream crossings and more. A mechanism for separating permitted activities from activities requiring consent is the Erosion Susceptibility Classification (ESC) of the land underlying the forest, found on the ESC maps, which cover most parts of New Zealand. The urban centre of Auckland (like most major centres) is not covered by an ESC. Because of this, advice should be sought from Auckland Council and/or the Ministry for Primary Industries on the applicability of the NES-PF given the activity's similarities to a commercial harvest. As a resource consent has already been granted for all the activities associated with the harvest, with wide-ranging and stringent conditions, assessing the activity against the NES-PF (if it does apply) may stand to add no material benefit to the goal of reopening the reserve to the public in a timely manner.

4.2 Weather Delays

As resource consent conditions are stringent with regard to soil and sediment movement, it is advised that extraction works are not carried out where rainfall exceeds 4mm in a 24hr period. This simple and self-imposed measure ensures no unnecessary damage occurs to the tracks which will; a) require repair, b) reduce traction, and c) pose a risk for sediment mobilisation if used during and immediately after rainfall.

Wind direction and strength can aid or hamper tree felling work. Some delays should be anticipated with the faller/arborist waiting for 'the right wind' to assist falling.

4.3 Contractor Responsibilities

The plan proposed in this report has not been prepared under the advice of a qualified tree faller or tree-climbing arborist. As such it is anticipated that the skills and experience of those contracted to carry out the works will be fully utilised during the development of daily/weekly/monthly operational plans to ensure quality of work practice and the safety of workers on-site. Local wind conditions and individual tree assessments, coupled with the tools available to the faller/arborist will influence tree falling decisions on a tree-by-tree basis. To specify the precise course of action for each tree at the strategic level is unwise, ignoring the skills and experience of the faller and potentially leading to unsafe practices (under specific conditions).

5 Conclusion

Removing the pine trees from Western Springs reserve is a valuable opportunity to assist the recovery of an important part of the local landscape while the native understorey is young. The reserve has diverse native flora, houses native and introduced fauna and provides a bush-like aesthetic to a predominantly built-up environment. While the pines have been a part of the visual landscape for decades, their deterioration has become a significant hazard to users of the reserve leading to its closure.

Management of individual at-risk trees has been considered, however with ongoing impacts such as the accumulation of large woody debris on site it is not the ideal option. Complete removal will allow native planting programmes to start, with no future risk of damage from tree fall or dismantling.

This report has proposed a pragmatic, low-impact harvest solution which meets the overall goal of reopening the reserve in a timely manner, while eliminating the future tree-fall risk to reserve users. The proposal requires the construction of a machine access track to the stand, similar to that planned under resource consent but with reduced impact through soil disturbance. The plan enables a staged or sequential removal of pines which is safe, productive and feasible. It also notes the importance of erosion control, and retaining native flora as far as practicable. Finally, the plan acknowledges the skills and experience of contractors and their ability to advise on operational plans. It is these skilled people that will realise the goal of opening the reserve to the public again.

6 Appendices

Appendix I: Project Brief
Appendix II: Harvest Plan
Appendix III: Felling Zones Map
Appendix IV: Primary Extraction Track RoadEng Plan v1
Appendix V: East Extension Track Option RoadEng Plan
Appendix VI: West Extension Track Option RoadEng Plan
Appendix VII: Wind Frequency Plots for Auckland City, NIWA

Appendix I: Project Brief

- *Onsite review of harvest system options (with client or Auckland Council staff in attendance if desired), including measurement of all parameters required for developing informed felling and extraction decisions.*

- *Basic harvest plan for preferred option(s) – including maps and supporting details.*

- *Short report covering the following aspects (as per scope set out by A. Benson)*
  - *Logistical consideration and constraints (e.g. site access, effects to the public)*
  - *Available felling and extraction methodologies with adv. and disadvantages for each*
  - *Anticipated timeframe for completing each option (consider complete or staged removal) for each method.*
  - *Description of potential damage to understory vegetation for different felling and extraction options.*
  - *Description of anticipated secondary effects to the remaining pine trees under different removal scenarios (e.g. edge effects & wind exposure resulting in tree failures).*
  - *Recommendations for the most appropriate felling and extraction approach (if deemed viable) in consideration of overall objectives (such as a staged harvest) and site constraints.*

Western Springs

Harvest Plan v2

UC UNIVERSITY OF CANTERBURY
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CHRISTCHURCH NEW ZEALAND

N

1753400 1753500 1753600 1753700 1753800 1753900

5919000 5918900 5918800 5918700

Notes:
Pine trees to be felled, delimbed and bucked on slope before extracting to track.
Trees that cannot be felled within the stand are to be dismantled by climbing arborist(s) PRIOR to felling surrounding trees except by agreement with the climbing arborist(s) undertaking dismantling work.
Slash >40mm in diameter & >1.5m long to be removed from site.
All other slash to be distributed on site away from overland flow paths.

Felling Zone 3
Felling Zone 2
Felling Zone 1
Existing Track
Fuel Storage
Landing
Parking

Legend

Road Component

- Centreline
- Running Surface
- Cut/Fill Extent
- GB Extraction Direction
- Felling Direction
- Fuel Storage
- Existing Track
- Landing
- Parking
- NZ Property Boundaries
- WESTERN_SPRINGS_SEWER_MH
- WESTERN_SPRINGS_STORM_WATER_MH
- Felling Zones
- WESTERN_SPRINGS_TREES_ATTR001
- WESTERN_SPRINGS_OFP
- WESTERN_SPRINGS_BRIDGE
- 1m Contour (2013 LiDAR derived)
- WESTERN_SPRINGS_PATH
- WESTERN_SPRINGS_STEPS
- WESTERN_SPRINGS_SEWER_PIPE
- WESTERN_SPRINGS_STREAM
- WESTERN_SPRINGS_STORMWATER_PIPE
- Lake

0 50 100 200 300 Meters

1:1,500

Date: 20/10/2020
Time: 11:57:06 am

Coordinate System: NZGD 2000 New Zealand Transverse Mercator
Projection: Transverse Mercator
Datum: NZGD 2000
False Easting: 1,600,000.0000
False Northing: 10,000,000.0000
Central Meridian: 173.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Map prepared by Prof. Rien Visser & Campbell Harvey, UC School of Forestry.

Western Springs

Felling Zones v1.0

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CHRISTCHURCH NEW ZEALAND

N

1753400 1753500 1753600 1753700 1753800

5919000 5918900 5918800

Felling Zone 3

Felling Zone 2

Felling Zone 1

Legend

- Felling Zones
- NZ Property Boundaries
- WESTERN_SPRINGS_SEWER_MH
- WESTERN_SPRINGS_STORM_WATER_MH
- WESTERN_SPRINGS_TREES_ATTR001
- WESTERN_SPRINGS_OFP
- WESTERN_SPRINGS_BRIDGE
- 1m Contour (2013 LiDAR derived)
- WESTERN_SPRINGS_PATH
- WESTERN_SPRINGS_STEPS
- WESTERN_SPRINGS_SEWER_PIPE
- WESTERN_SPRINGS_STREAM
- WESTERN_SPRINGS_STORMWATER_PIPE
- Lake

Terrain Slope

- 0 - 18 deg
- 18 - 22 deg
- 22 - 28 deg
- 28 - 35 deg
- 35 - 45 deg
- 45+ deg

0 50 100 200 300 Meters

1:1,250

Date: 26/09/2020
Time: 4:16:43 PM

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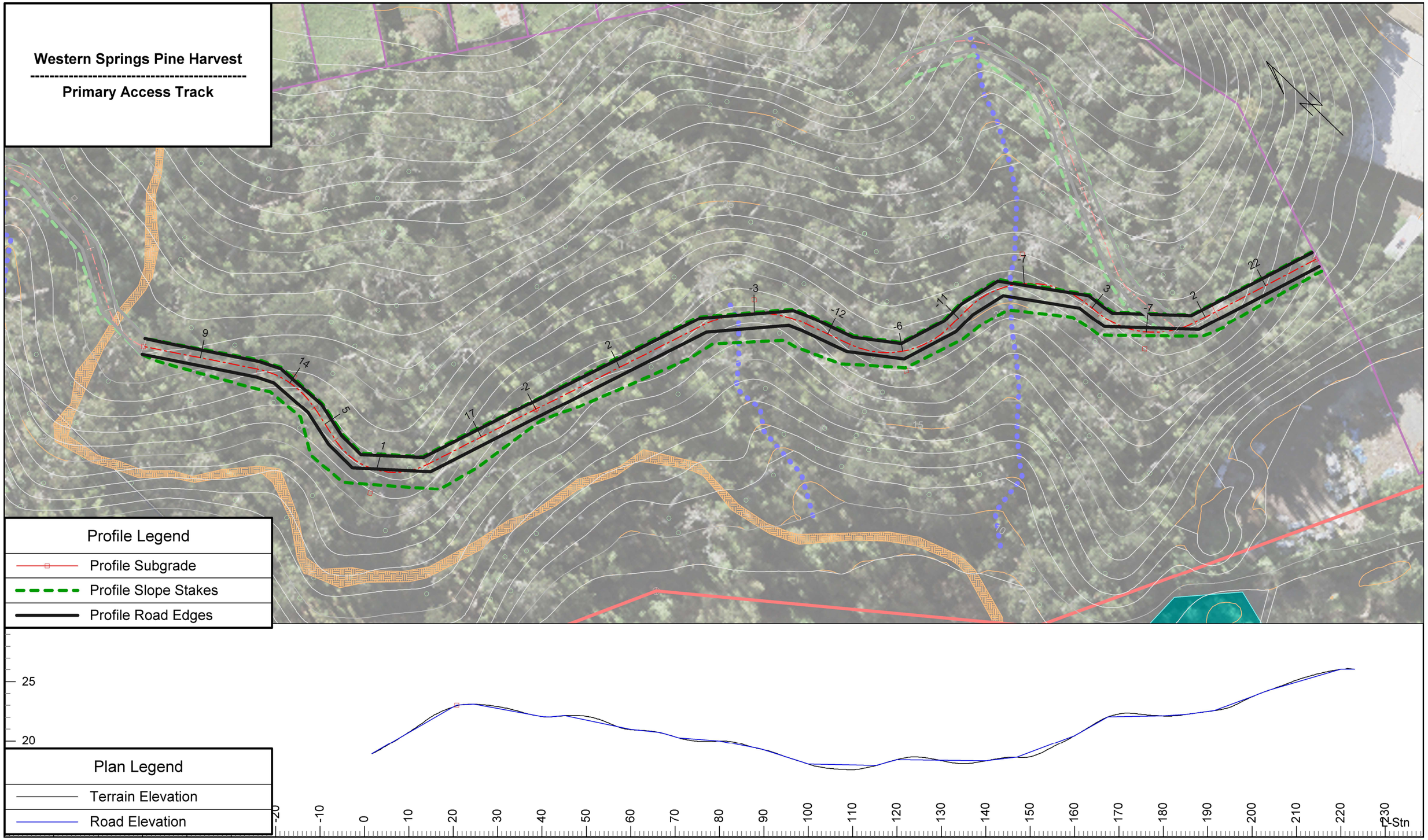
False Northing: 10,000,000.0000
Central Meridian: 173.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

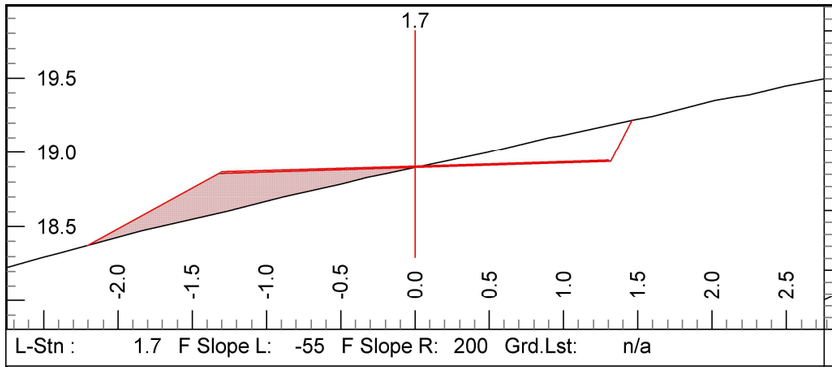
Map prepared by Prof. Rien Visser & Campbell Harvey, UC School of Forestry.

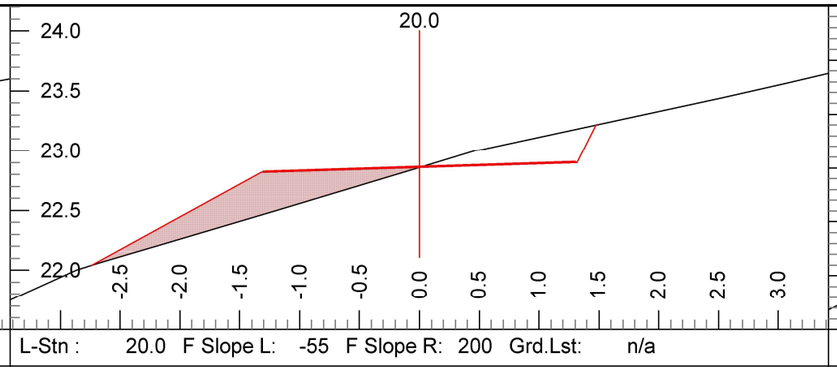
Western Springs Pine Harvest

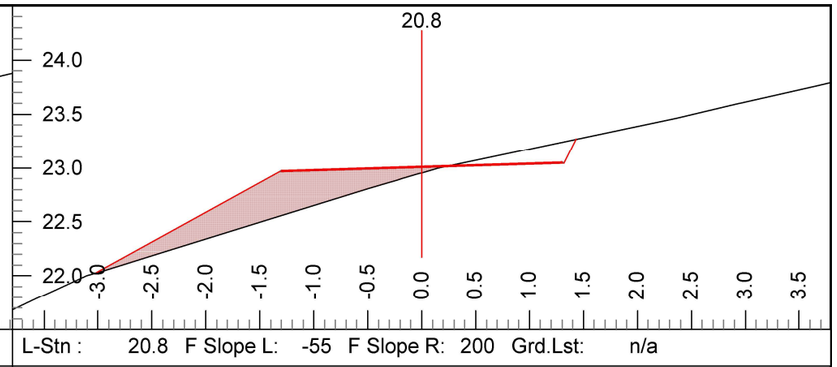
Primary Access Track

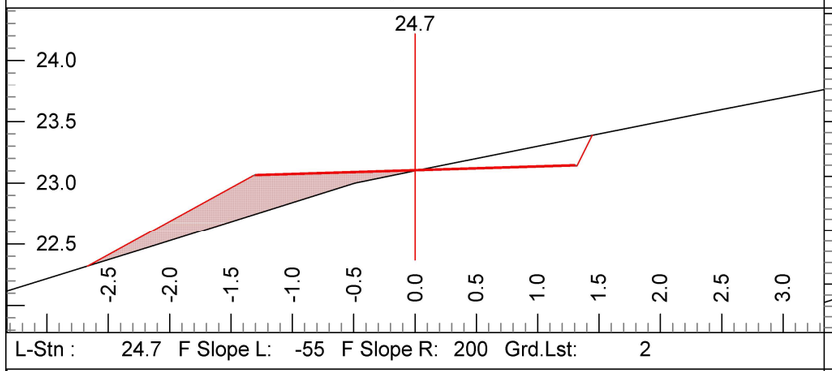


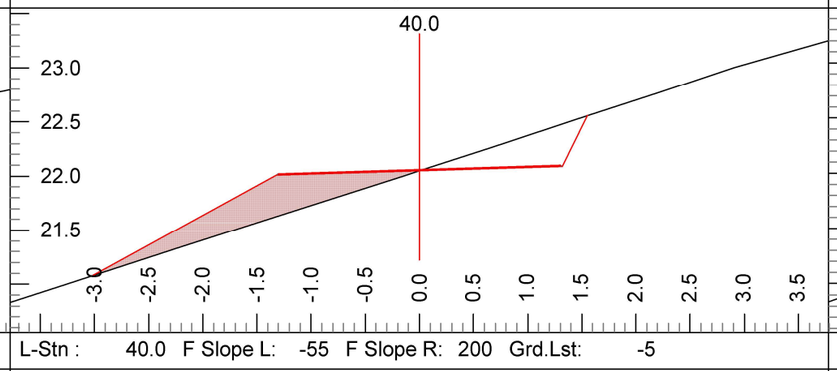
Station Range		Profile Vert Scale 1:300 Profile Horz Scale 1:800	Plan Scale 1:600	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury NZ School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
1.7	223.2							Sheet 1 of 4	26/09/2020

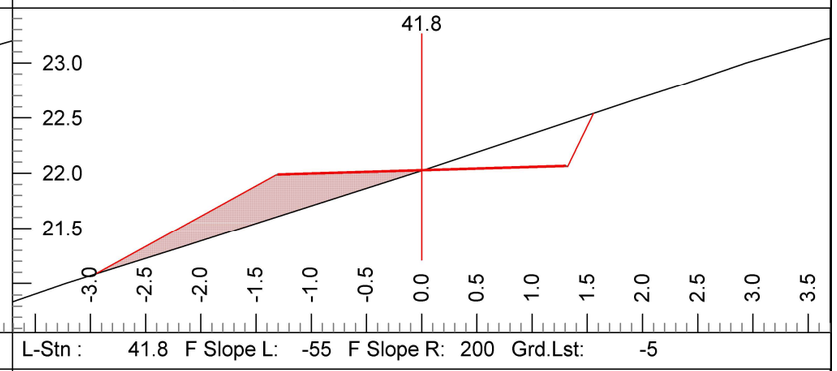


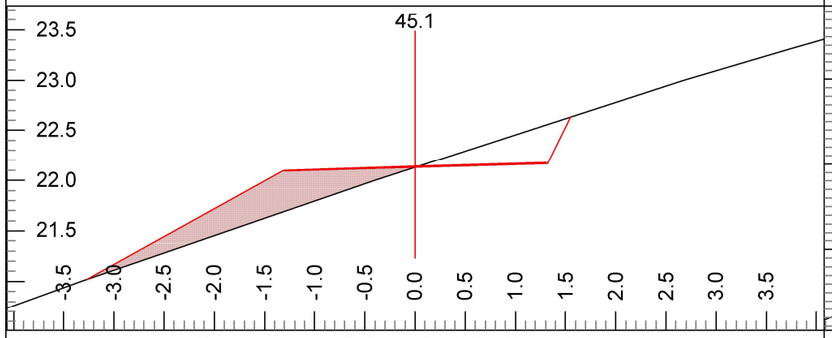


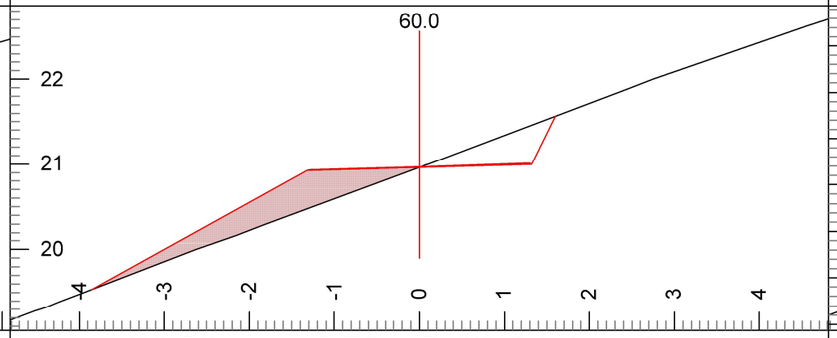


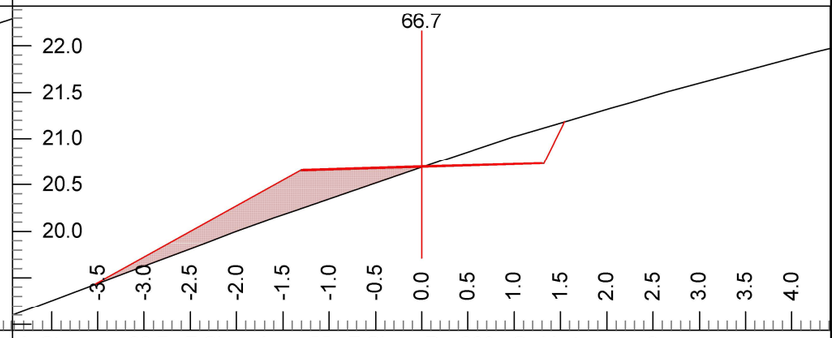


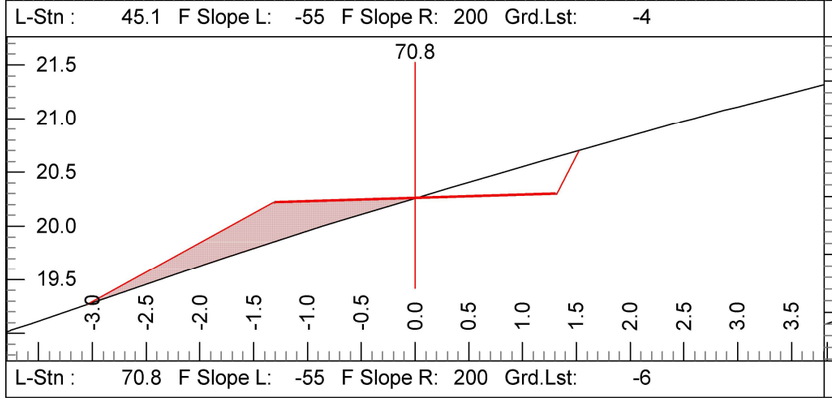


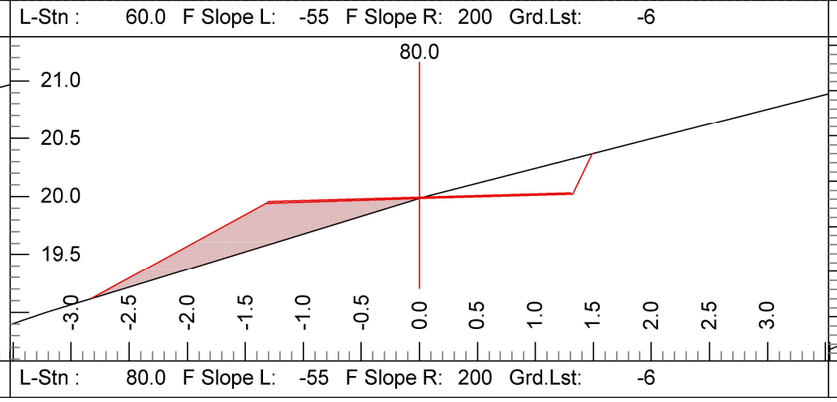


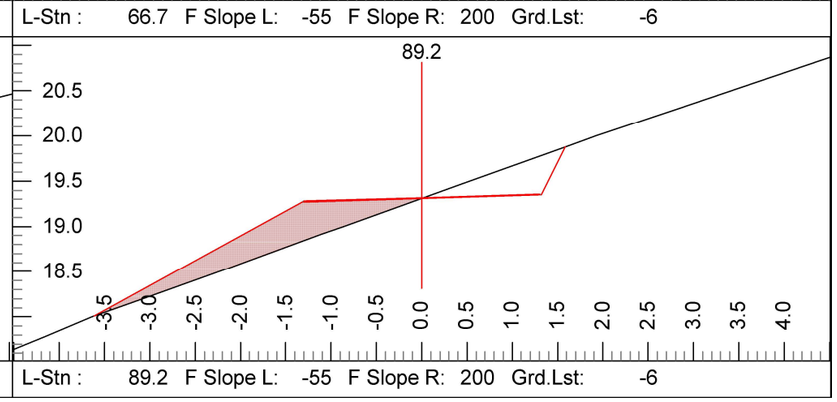




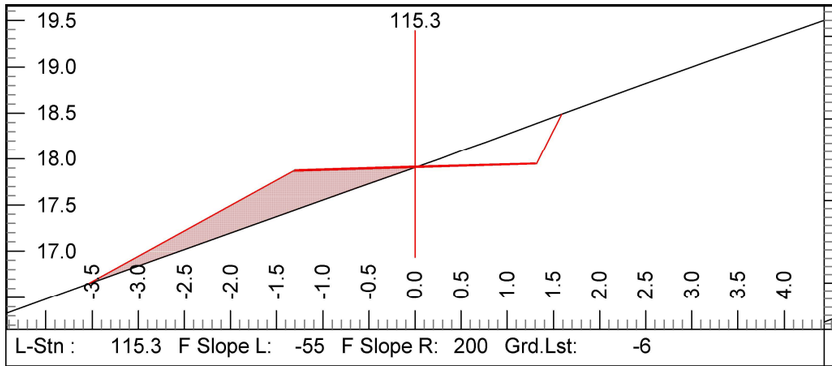


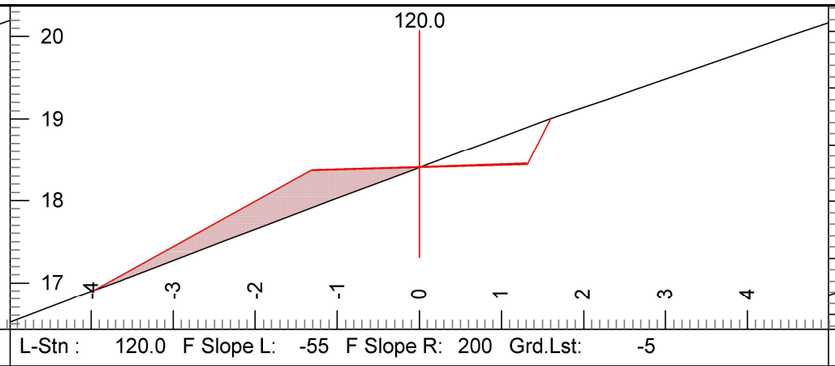


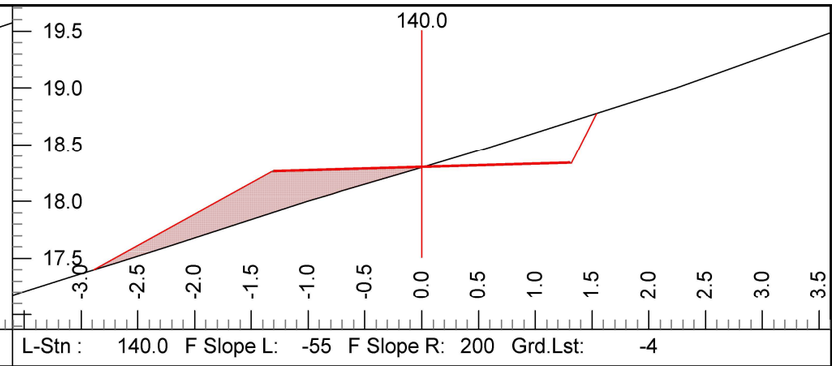


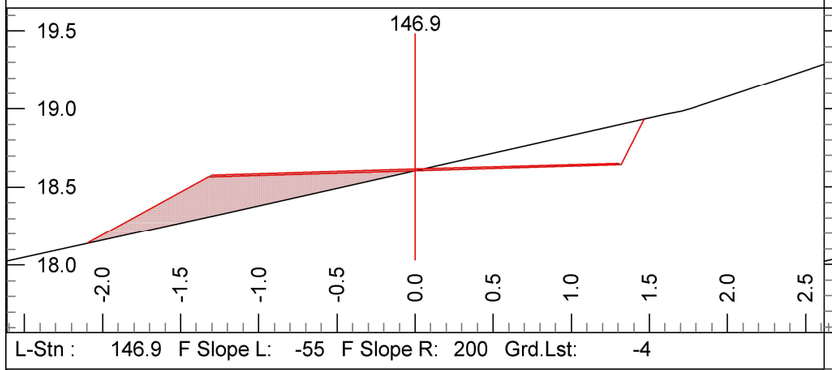


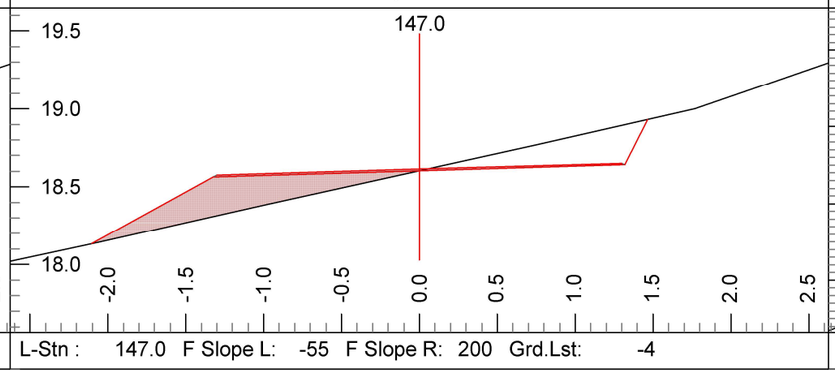
Station Range		Section Scale 1:68	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
1.7	101.7						Sheet 2 of 4	26/09/2020

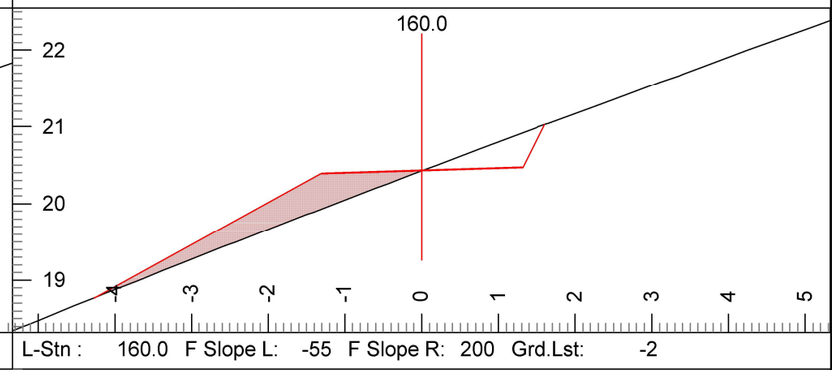


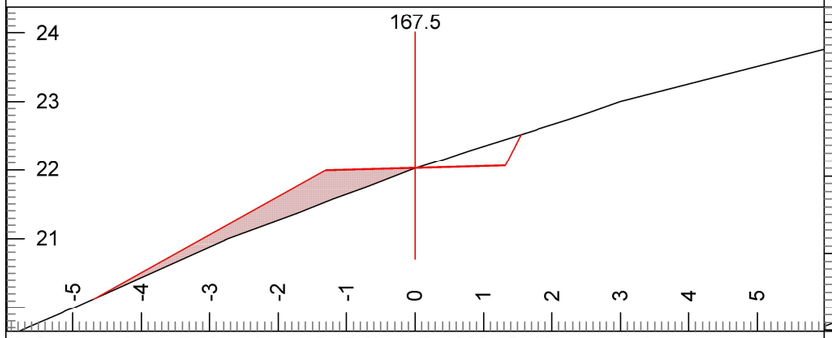


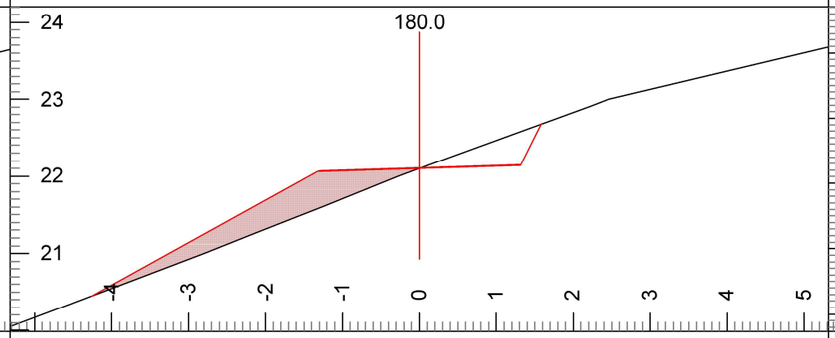


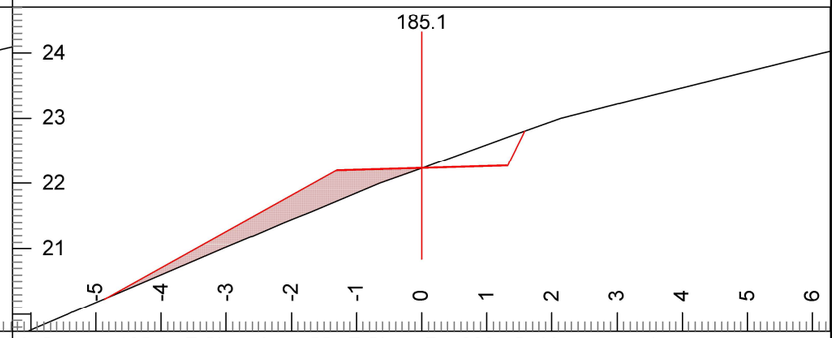


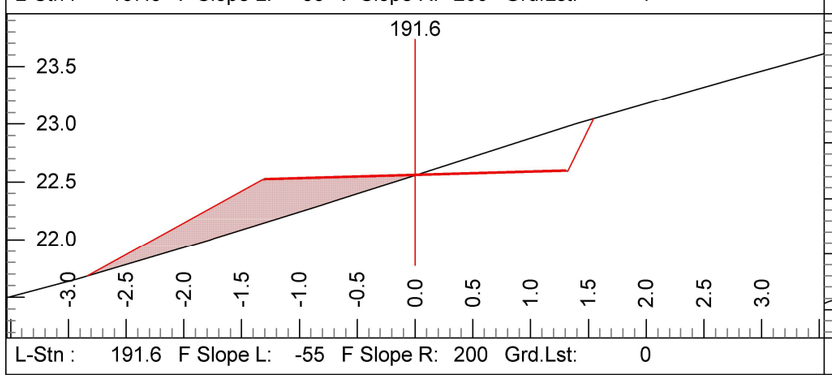


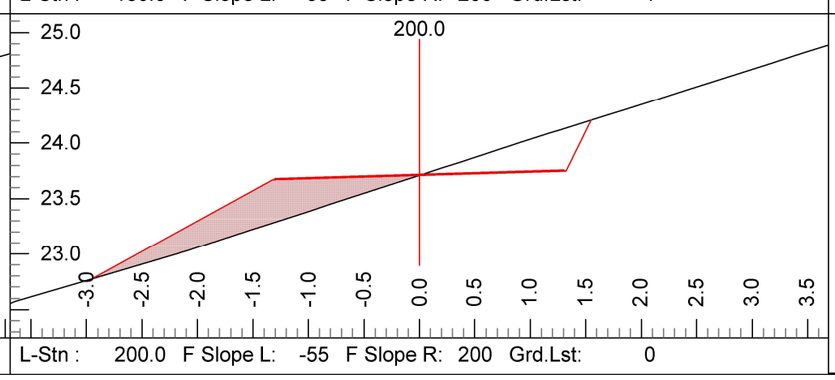




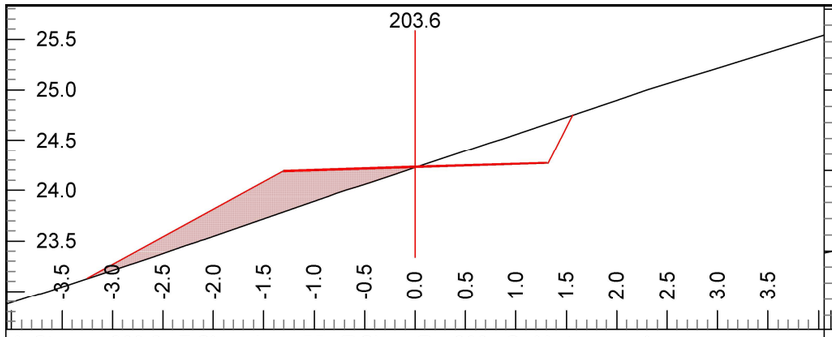




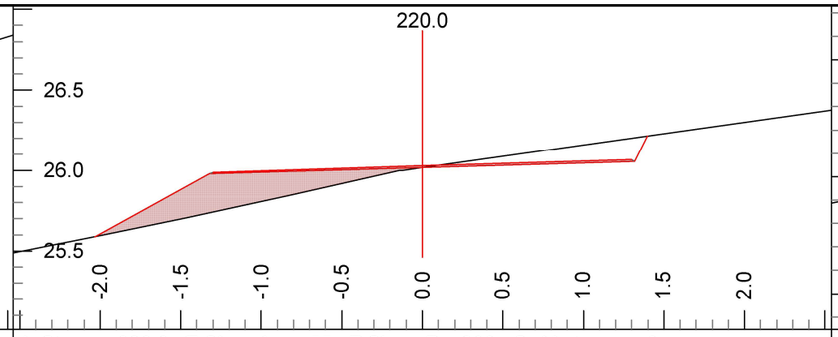




Station Range		Section Scale 1:68	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
101.7	201.7						Sheet 3 of 4	26/09/2020



L-Stn : 203.6 F Slope L: -55 F Slope R: 200 Grd.Lst: 1



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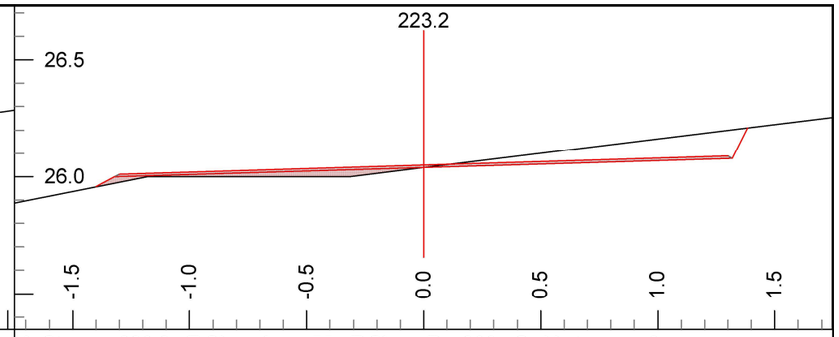

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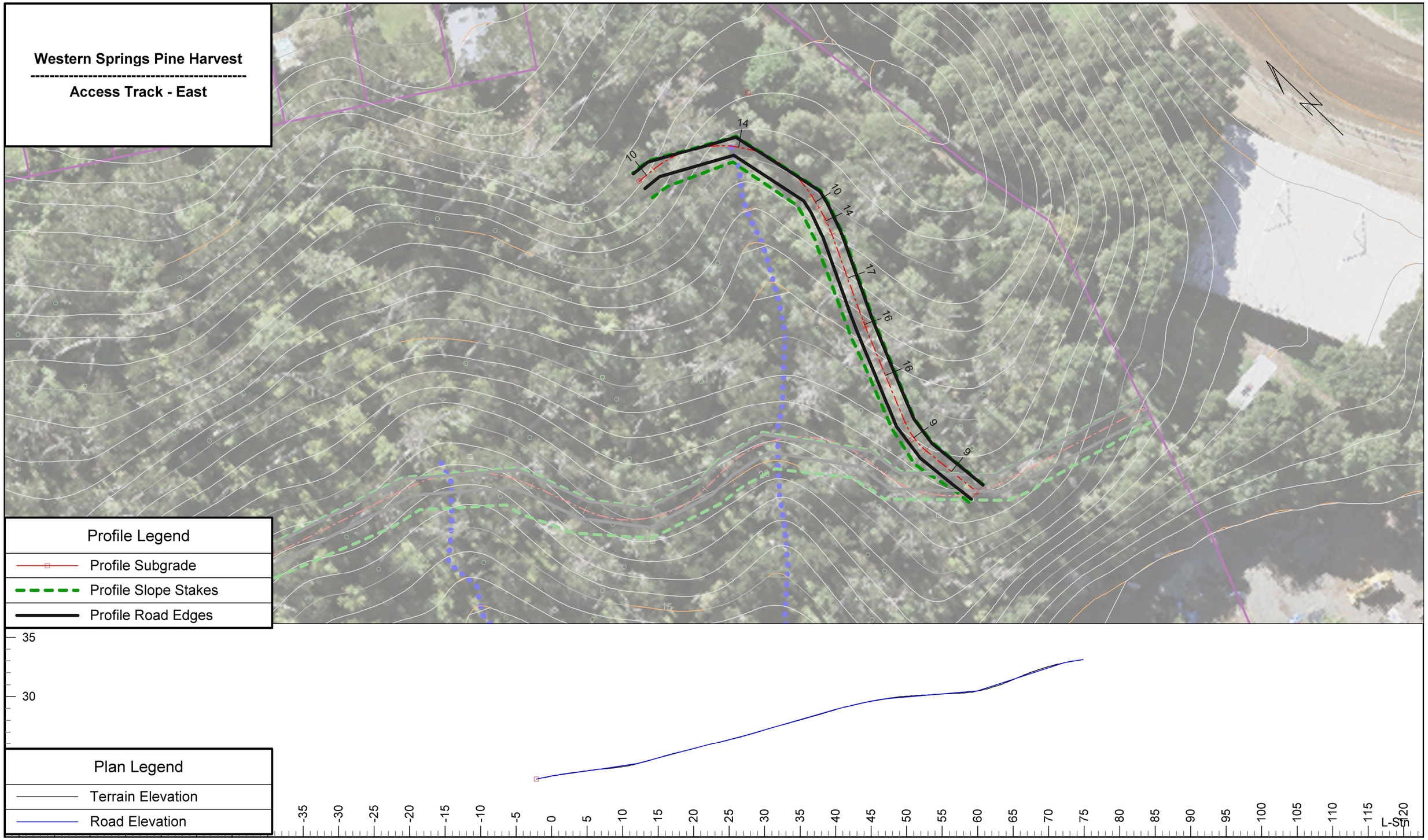
Station Range		Section Scale 1:55	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
201.7	223.2						Sheet 4 of 4	26/09/2020

Western Springs Pine Harvest

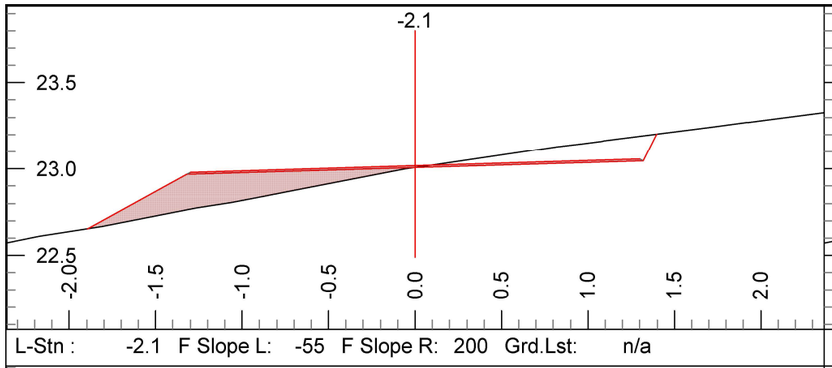
Access Track - East



Profile Legend
Profile Subgrade
Profile Slope Stakes
Profile Road Edges

Plan Legend
Terrain Elevation
Road Elevation

Station Range		Profile Vert Scale 1:300 Profile Horz Scale 1:500	Plan Scale 1:500	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury NZ School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
-2.1	74.8							Sheet 1 of 2	26/09/2020



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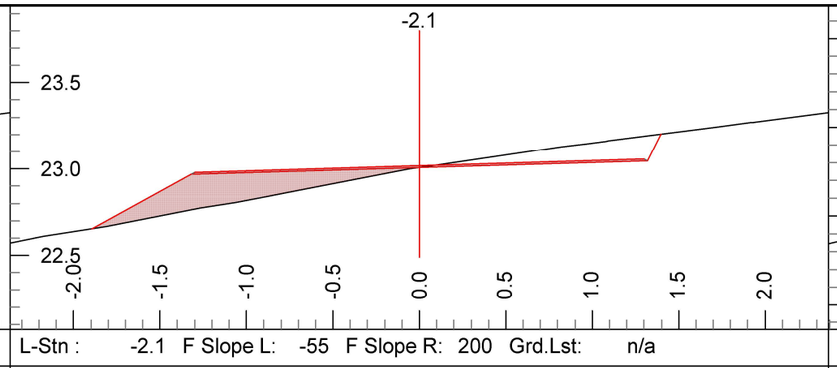

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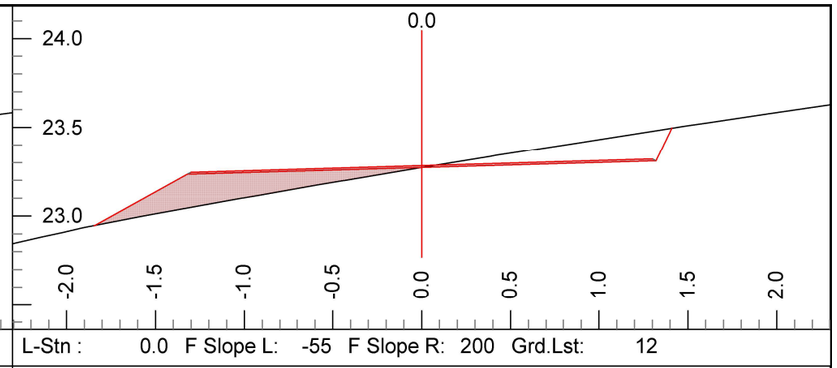

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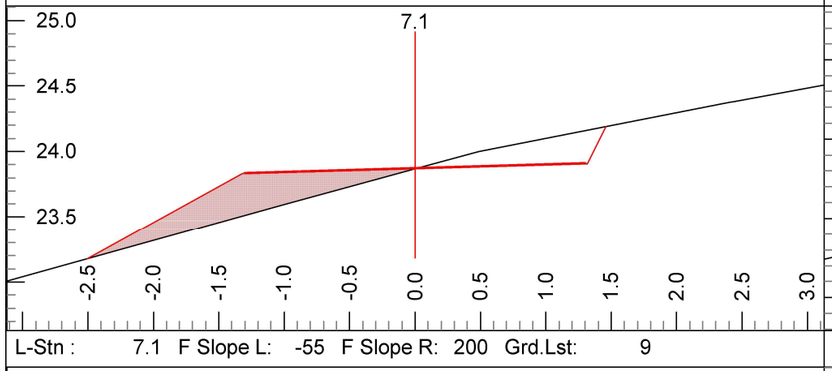

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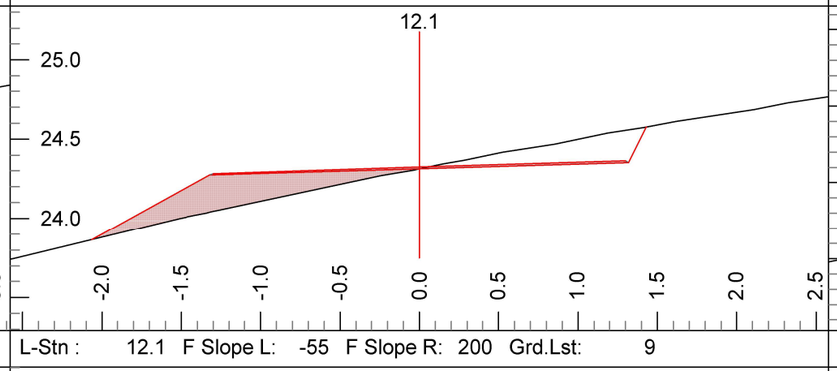

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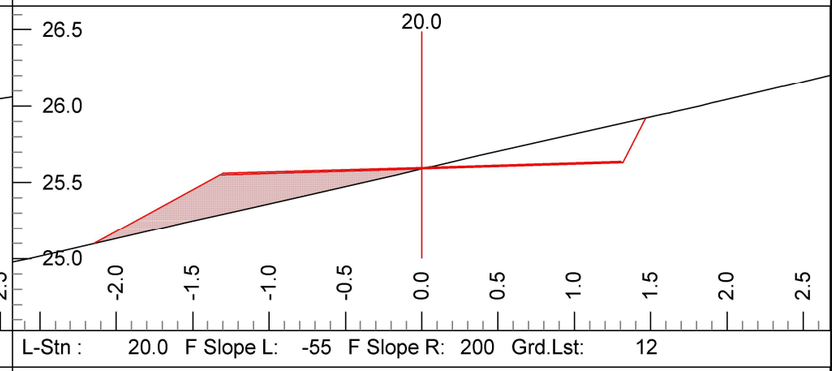
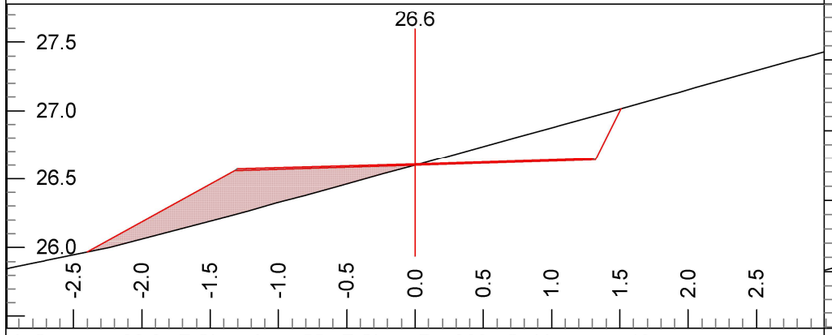
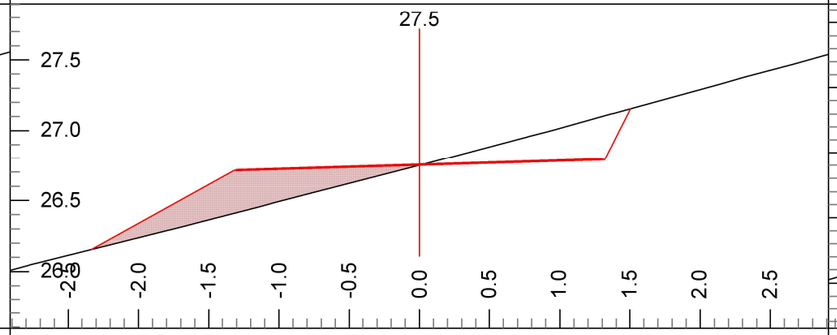


L-Stn : 20.0 F Slope L: -55 F Slope R: 200 Grd.Lst: 12



L-Stn : 26.6 F Slope L: -55 F Slope R: 200 Grd.Lst: 13



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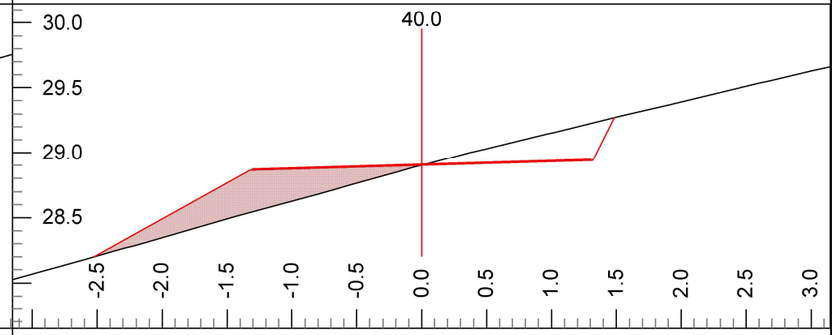

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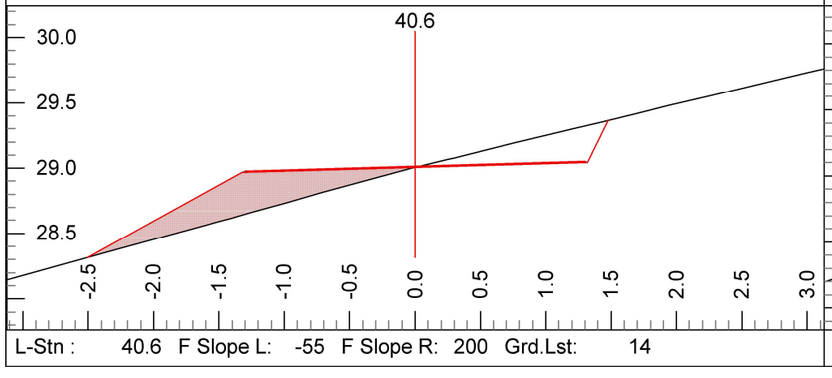

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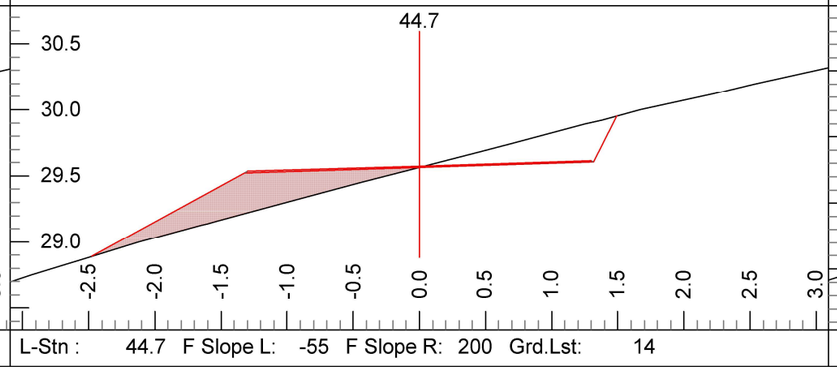

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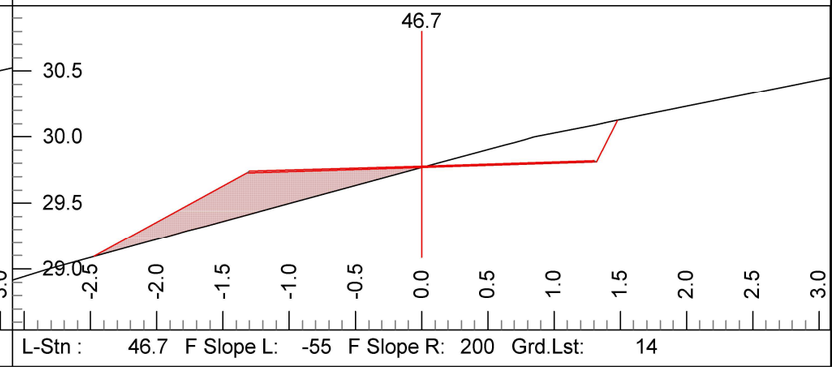
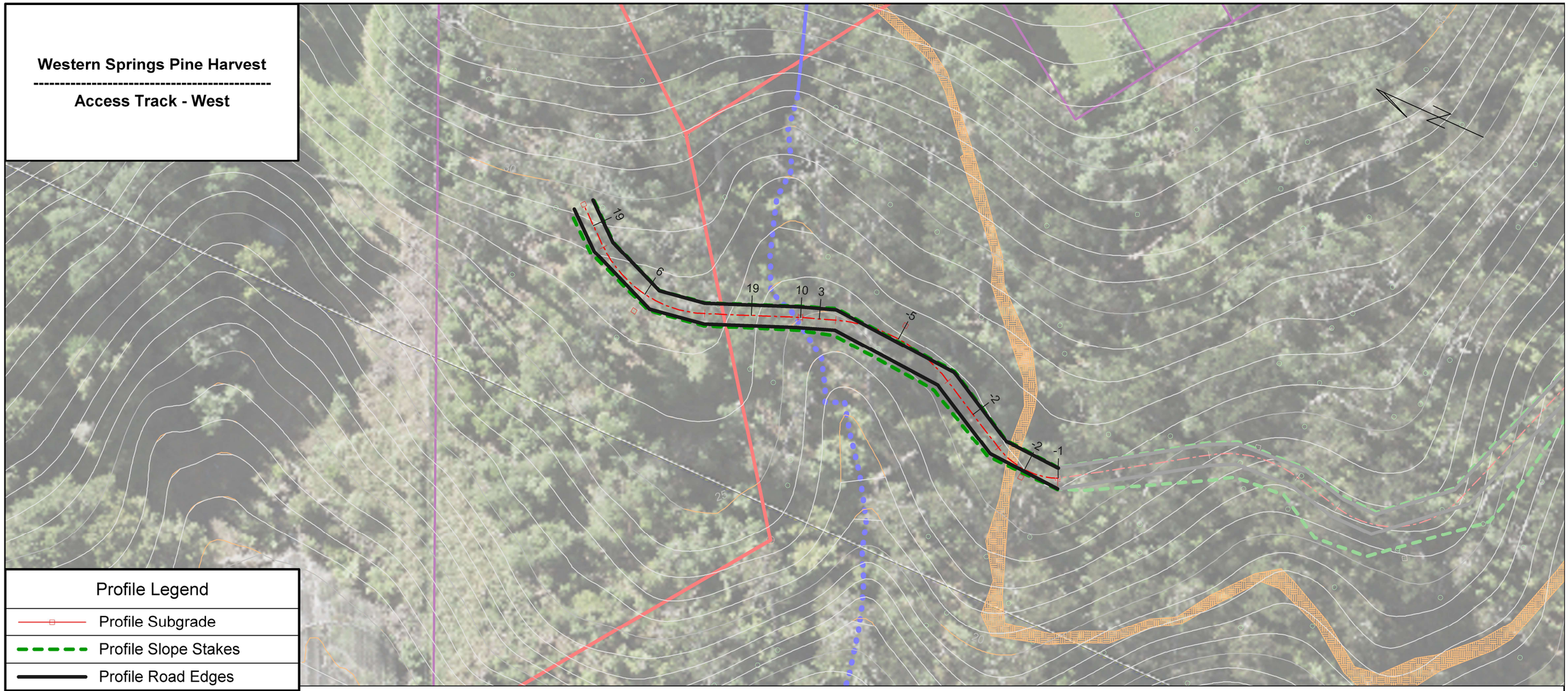


L-Stn : 46.7 F Slope L: -55 F Slope R: 200 Grd.Lst: 14

Station Range		Section Scale 1:46	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	Access Track - East 2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
-2.1	74.8						Sheet 2 of 2	26/09/2020

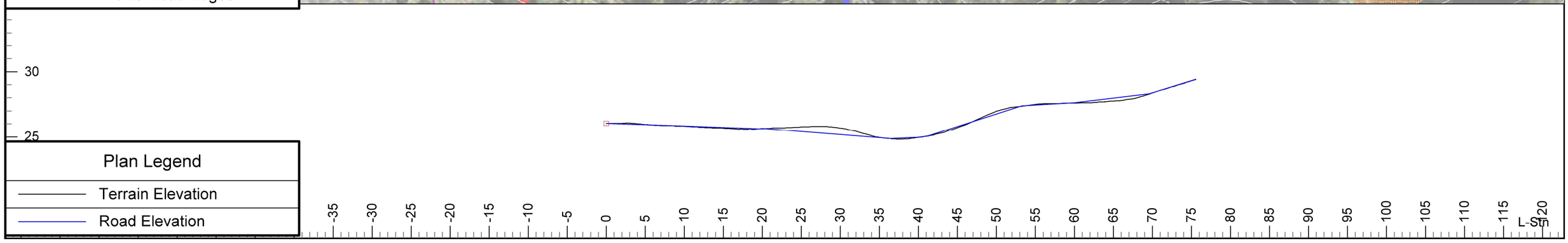
Western Springs Pine Harvest

Access Track - West



Profile Legend

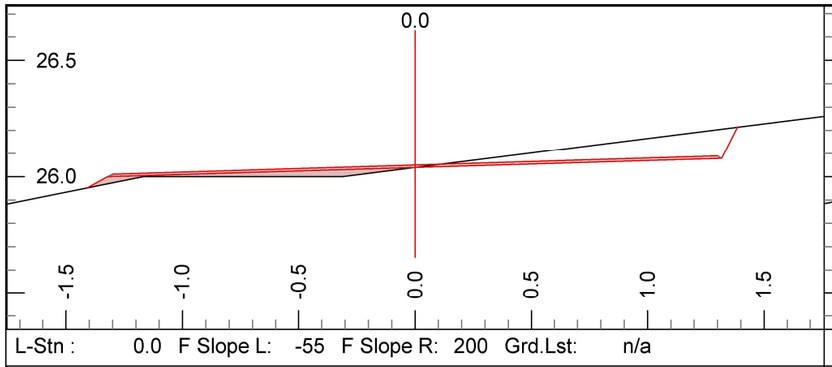
- Profile Subgrade
- Profile Slope Stakes
- Profile Road Edges



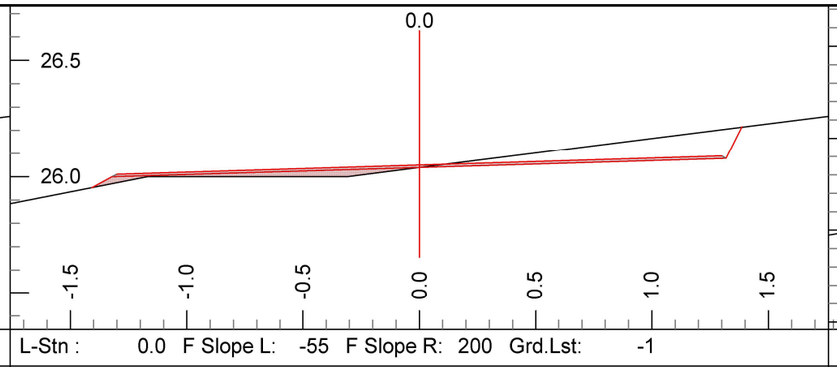
Plan Legend

- Terrain Elevation
- Road Elevation

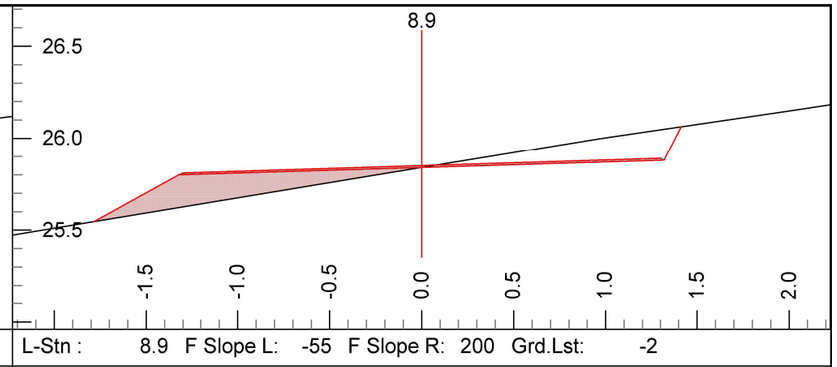
Station Range		Profile Vert Scale 1:300 Profile Horz Scale 1:500	Plan Scale 1:500	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury NZ School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
0.0	75.6							Sheet 1 of 2	26/09/2020



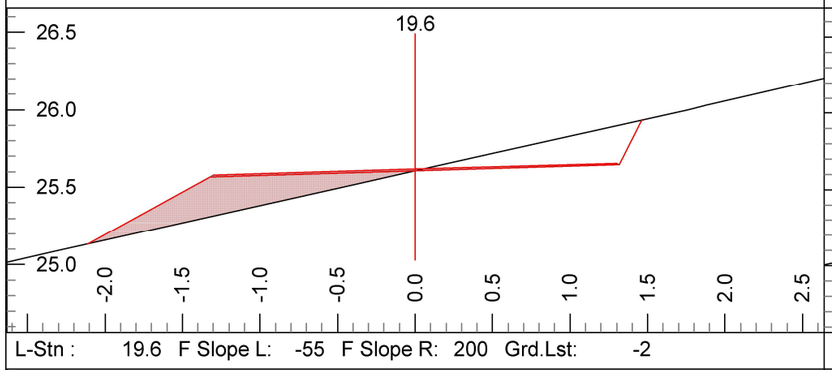
L-Stn : 0.0 F Slope L: -55 F Slope R: 200 Grd.Lst: n/a



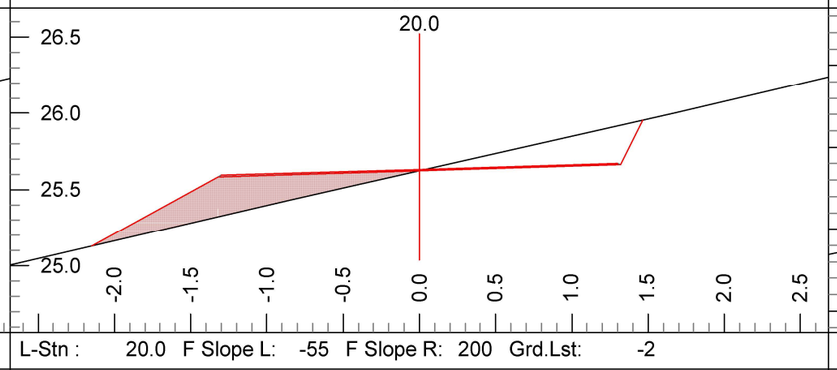
L-Stn : 0.0 F Slope L: -55 F Slope R: 200 Grd.Lst: -1



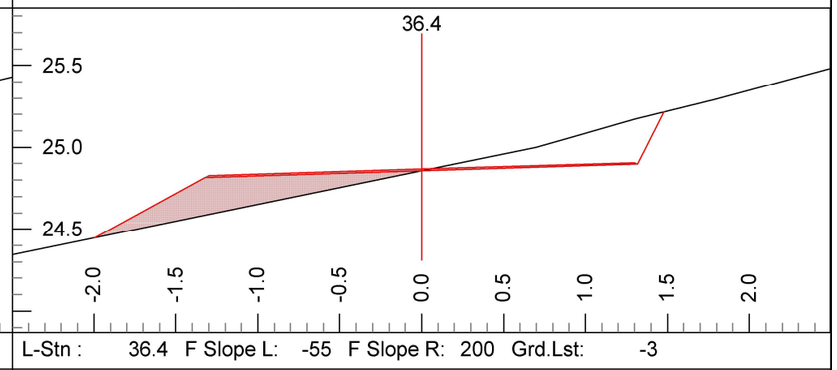
L-Stn : 8.9 F Slope L: -55 F Slope R: 200 Grd.Lst: -2



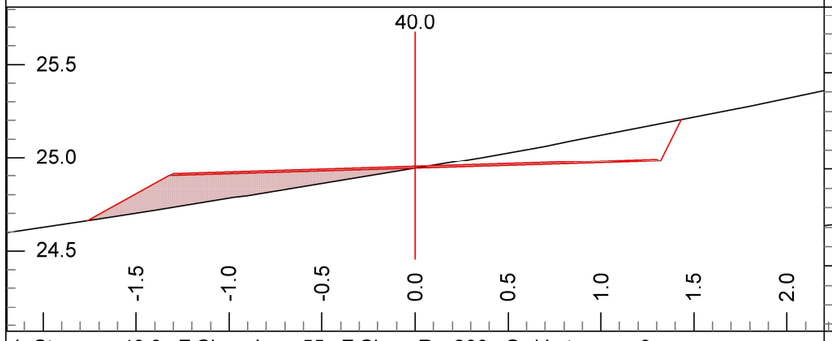
L-Stn : 19.6 F Slope L: -55 F Slope R: 200 Grd.Lst: -2



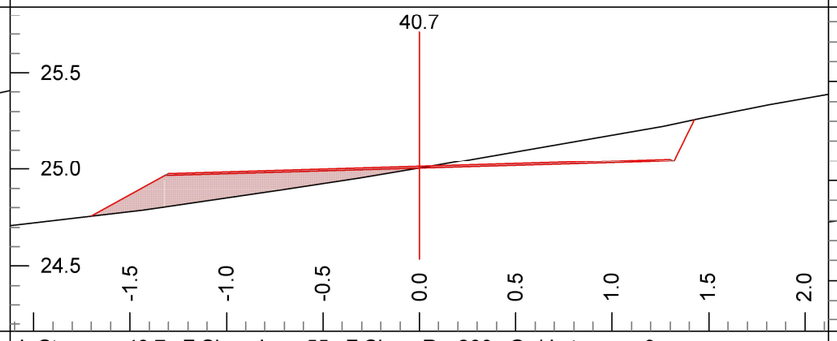
L-Stn : 20.0 F Slope L: -55 F Slope R: 200 Grd.Lst: -2



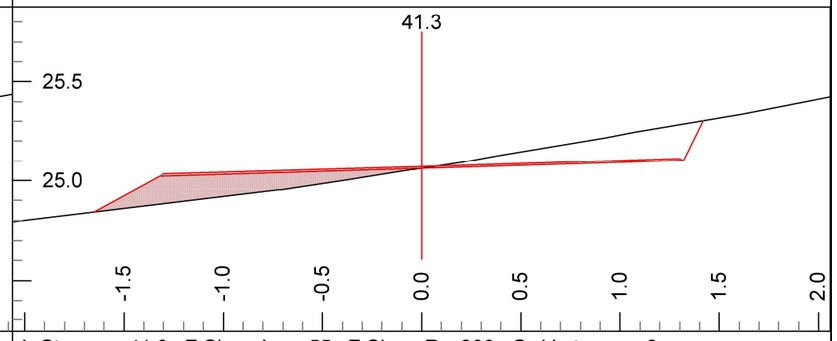
L-Stn : 36.4 F Slope L: -55 F Slope R: 200 Grd.Lst: -3



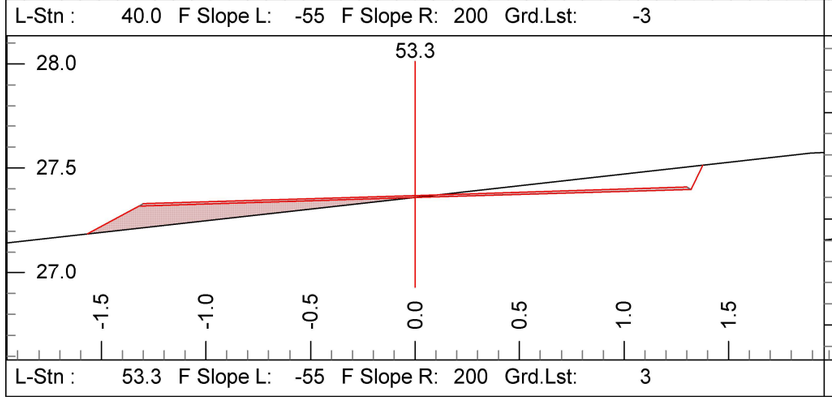
L-Stn : 40.0 F Slope L: -55 F Slope R: 200 Grd.Lst: -3



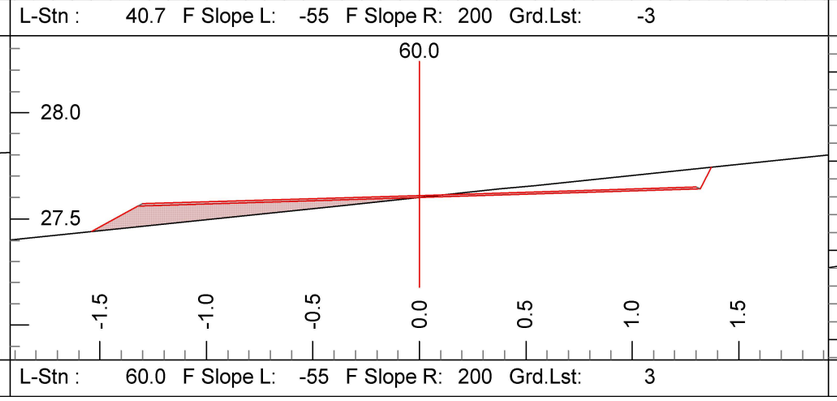
L-Stn : 40.7 F Slope L: -55 F Slope R: 200 Grd.Lst: -3



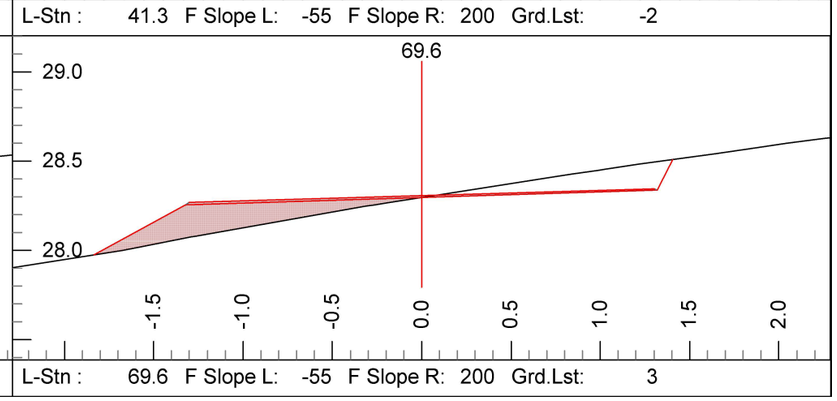
L-Stn : 41.3 F Slope L: -55 F Slope R: 200 Grd.Lst: -2



L-Stn : 53.3 F Slope L: -55 F Slope R: 200 Grd.Lst: 3



L-Stn : 60.0 F Slope L: -55 F Slope R: 200 Grd.Lst: 3



L-Stn : 69.6 F Slope L: -55 F Slope R: 200 Grd.Lst: 3

Station Range		Section Scale 1:34	Notes: Track designed to be low-impact and easily recontoured to slope. Use for temporary access. Apply aggregate to OFP crossings and adverse grades.	Access Track - West 2.6m wide track 3% surface outslope 200% cut slope 55% fill slope	University of Canterbury School of Forestry	UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND	Designed By: Rien Visser & Campbell Harvey	
0.0	75.6						Sheet 2 of 2	26/09/2020

CLIMATIC ELEMENTS

Wind

The airflow over Auckland is predominantly from the southwest. This is particularly so in winter and spring, but in summer the proportion of winds from the northeast increases. This arises from the changing location of the high pressure belt, which is further south in summer and early autumn than it is in winter and spring. In addition, sea breezes add to the proportion of easterlies in eastern areas in summer and early autumn. Figure 6 shows mean annual wind frequencies of surface wind based on hourly observations from selected stations.

Mean wind speed data (average wind speeds are taken over the 10 minute period preceding each hour) are available for several sites in Auckland, and these illustrate the several different wind regimes of the region. Coastal areas (e.g. Auckland Airport) tend to be windier throughout the year compared with sheltered inland areas (e.g. Pukekohe). Table 1 gives mean monthly and annual wind speeds for selected stations in Auckland.

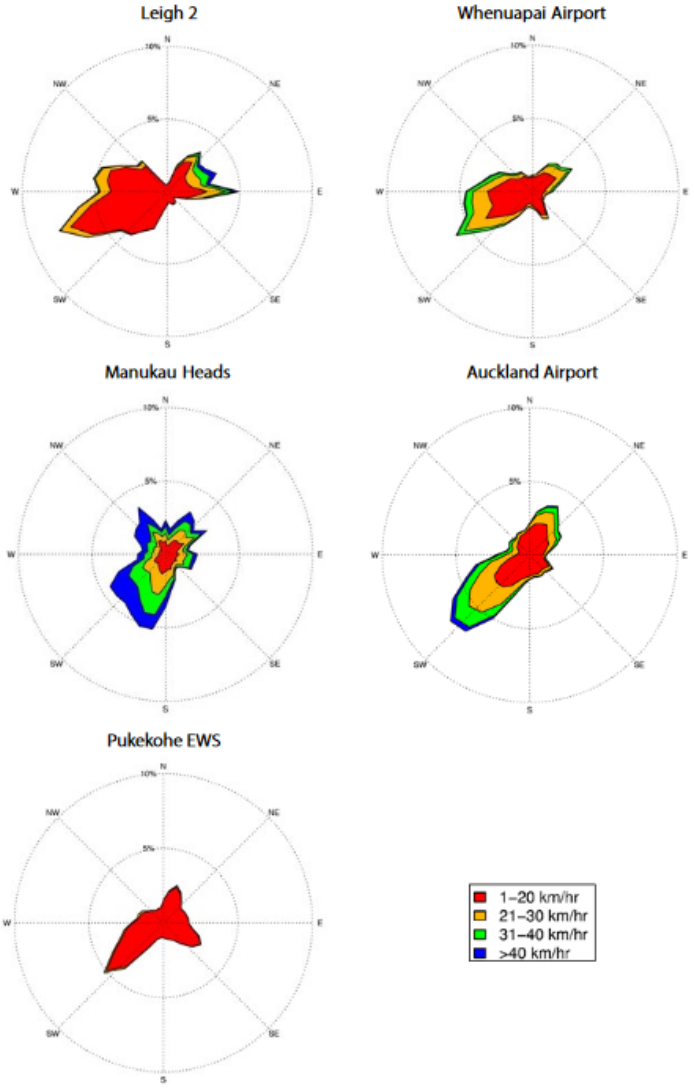


Figure 7. Mean annual wind frequencies (%) of surface wind directions from hourly observations at selected Auckland stations. The plots show the directions from which the wind blows, e.g. the dominant wind direction at Auckland Airport is from the southwest.

Source: Excerpt from 'The Climate and Weather of Auckland', 2nd Ed. P.R. Chappell, NIWA