29 November
2022

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Dunedin Railways

Taieri Gorge Railway

Infrastructure Inspection : Strategic Overview

Prepared for / **Dunedin City Council**

Project No. / **V-1105**

Revision / Rev 0.2

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Document Control Record

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1 Purpose

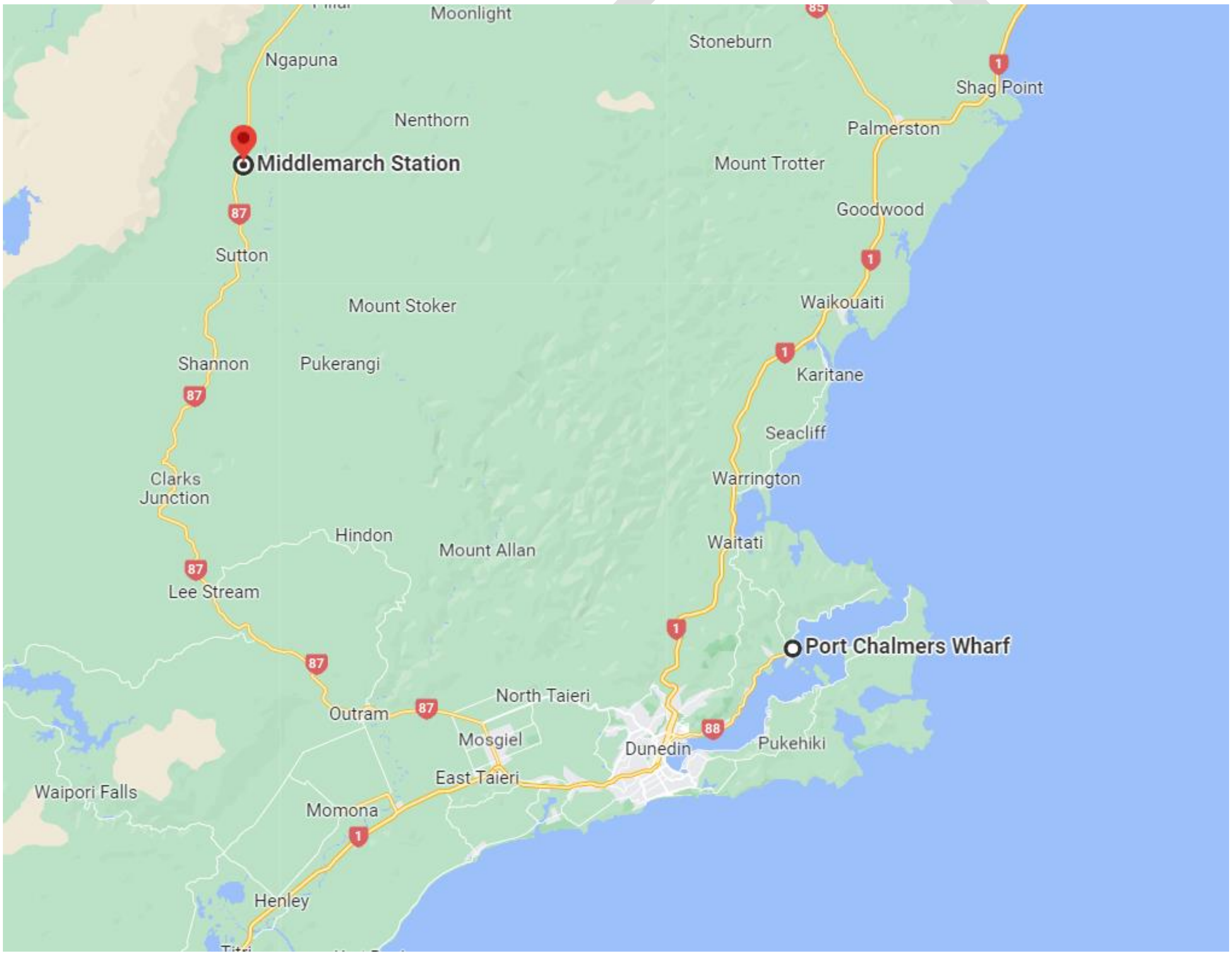
The private railway through the Taieri Gorge to Middlemarch is operated by Dunedin Railways (DR) and owned by Dunedin City Council (DCC).

DCC require a ten year business planning model to describe the activities and outline anticipated costs needed to maintain and upgrade the railway to the necessary level of service. This plan will identify requirements over three phases;

1. Immediate requirements
2. From 3 to 5 years
3. From 5 to 10 years

The train service caters for domestic and international tourism. The cruise boat sector creates good demand and interest during the cruise season.

The train service is currently only operating between North Taieri and Hindon



2 Scope

The DCC have requested and commissioned Vitruvius to undertake a condition assessment of the route infrastructure and determine the level of investment required over the next ten years to enable train services to continue operating at a sustainable performance level. The level of investment would be based on the appropriate operating strategy for passenger trains to use the infrastructure and satisfy all safety and operational requirements.

This assessment has been split into sections thus;

1. Sector 1 : 4km to Hindon (26.5 km) currently in use
2. Sector 2 : Hindon (26.5 km) to Pukerangi (45 km)
3. Sector 3 : Pukerangi (45 km) to Middlemarch (64 km)

The scope of the study and strategy includes an assessment of the following rail infrastructure assets;

- Rail
- Sleepers
- Fastenings
- Ballast
- Formation and drainage
- Culverts
- Vegetation
- Level crossings
- Bridges
- Tunnels

2.1 INSPECTION PROCESS AND FOCUS AREAS

Factual information and historic references have been provided to Vitruvius in the form of track logs. This data included condition rating to assist and determine where walking inspections were required to closely inspect and to provide condition details.
The track was inspected visually on foot and observed from the DCC hi-rail vehicle (HRV) on the 01/11/2022 to 04/11/2022.

2.1.1 Rail

The rail was inspected for condition and integrity with a focus on many items including, but not limited to ;

- Condition of the running surface.
- General rail wear and wheel/rail contact bands
- Joints including condition, fishplates and fishbolt security
- Rail corrosion in the web and foot regions with particular focus in tunnels

Random rail wear sites were identified and measured using standard rail wear gauges to verify the wear figures presented on track logs.

2.1.2 Sleepers

Inspection of the sleepers included the following items;

- General condition with emphasis on the amount of decay
- Ability to provide fastening security
- Rail and/or bedplate cutting into the sleeper surface
- Number of sleepers life expired

2.1.3 Fastenings

Fastening inspection focused on the following;

- Type and appropriateness of fastenings
- Fastening security i.e. holding the rail in position as required
- Areas where multiple fastenings were ineffective

2.1.4 Ballast

The ballast inspection was looking primarily at elements that are required for effective track;

- Security for positioning the sleepers and hence overall track
- Provide the ability to manage track geometry
- Size and cleanness of the ballast

2.1.5 Formation and Drainage

There were some key elements and objectives observed in light of the following;

- Is the drainage taking water away from the track and formation
- Is there formation failure due to poor or degraded materials – what are the primary causes of failure
- Do the embankments and cuttings appear to be secure or prone to failure
- Is there water causing rail corrosion or accelerated degradation in tunnels

2.1.6 Culverts

The culvert inspection looked at the elements that are required for effective track;

- Security for the formation through control of water movement
- Provide the ability to manage water from rainfall and adjacent catchments
- Taking water from the railway into adjacent watercourses
- Location of the inlet and outlet for maintenance purposes

2.1.7 Vegetation

The management of vegetation in the railway corridor is necessary for many reasons. The inspection focus was to determine the current state of vegetation control.

- Where there is the risk of trees falling and fouling the line during wet and/or windy weather conditions
- General weed growth in the drainage or ballast
- Is there the required clearance for rolling stock
- Is there vegetation likely to cause damage to passenger carriages

2.1.8 Level Crossings

The observations around the interface between road and rail was assessed with the following topics as focus points;

- Adequate signage to warn road users of the railway line
- Effective communication strategy with local communities and users
- Suitable viewlines for road and rail users
- Keeping flangeways clear for railway rolling stock and HRV's
- Each crossing needs a form of agreement with the appropriate people (Private crossings) or Road Controlling Authorities (RCA) for Public Roads.

3 Factual

The track and structures were inspected over four days from 1 to 4 November 2022. The inspection was undertaken with assistance from DR who provided a hi-rail vehicle and driver with good local knowledge.

DR provided copies of the track logs and bridge general inspection reports to assist Vitruvius and sub-consultant Holmes Group.

3.1 RAIL

The rail is generally 70 lb/yd and in short lengths (12 m) jointed with fishplates. Rail wear is being measured and recorded by DR staff during inspections. There were some locations of fishplates fouling the rolling stock wheel flanges.

Rail weight, age, condition and wear are all recorded on the track logs.

3.2 SLEEPERS

There is a mix of several different sleeper types within the TGR;

- Mixed Australian Hardwoods (MAH) generally older age
- Jarrah (a type of Australian hardwood)
- Treated Pinus Radiata (TPR)
- Ground treated TPR (GTPR) which are treated to H4 standard

Sleeper condition rating is recorded on the track logs

3.3 FASTENINGS

The track fastenings included the following;

- R type (ribbed bedplate with screwspike and clip)
- N type (flat bedplate with screwspike and clip)
- A clip (A)
- Elastic spike (E)
- Dog spike (D)
- Rail clip and screwspike with no washer (S)
- Flat bedplate and screwspike, rail clip with no washer (F)

Many of the fastening types in the railway are legacy from the New Zealand Railways era. There are different screwspike types required for softwood (GTPR OR TPR) sleepers and hardwood sleepers (MAH or Jarrah)

These fastening types are detailed in KiwiRail standards

3.4 BALLAST

Track ballast is a mix of several categories including the following;

- very good 40 or 65 mm clean stone aggregate
- shingle, river run or pit run which is smaller than 40 mm
- the ballast profile was variable throughout

3.5 FORMATION & DRAINAGE

The railway was constructed through remote sections of central Otago and as such is often in rock cuttings.

While the formation appeared to be generally stable there were many sections with water ponding in trackside cess drains.

Although the ballast type was often not good for transfer of water into the cess drains there was very little evidence of formation failure.

There were several locations where slips or debris had caused fouling of the cess drains and ballast. Many areas in sector 2 had goats and sheep wandering on the railway. Often they took a longitudinal path just off the end of the sleeper and had caused the ballast shoulder to be removed.

3.6 CULVERTS

The culverts were identified on site by a marker, refer Photo 4.4

Many culverts were blocked or partially open to allow water to be transferred as designed. As shown in sections 2.1.6 and 5.6 the effectiveness of culverts has differing risks according to position.

Some culverts would be taken small amounts of water from the cutting side to the river side of the railway. However there were many culverts in the bottom of constructed embankments which are more critical. If these culverts were blocked during high rainfall this puts the integrity of the embankment at risk.

3.7 VEGETATION

There are many trees that are at risk of fouling the track should they fall over from their current position. Many of these are noted in the track logs so have been identified by DR staff.
The section from Hindon to Pukerangi and Pukerangi to Middlemarch has trackside growth and growth at rail level. This has primarily been caused through the railway being mothballed during the 2020 – 2021 period.
The section through to Hindon that is being used currently and is in better condition for vegetation control.

3.8 LEVEL CROSSINGS

There are many level crossings that cross over the railway. These ranged from private crossings to public crossings including State Highway No.87.
The bridges that are used by both road and rail vehicles are a special circumstance as the road approaches to the bridges have road vehicles moving along the rail rather than across the rail.

Track geometry

- Cant (superelevation) does not match the line speed and hence too much cant.
- Difficult to lower cant (need a tamper)
- Curves are well defined with run in/out for the transitions
- Curve radius is shown on the Track Logs

4 Observations

The track and structures were inspected over four days from 1 to 4 November 2022. Vitruvius Track Inspector(s) travelled the route with input from the local Dunedin Railway staff.

4.1 INFORMATION

Track Logs being referenced include a record of the asset information for each 1 kilometre (km) length of track for the entire route through to Middlemarch. Track logs were considered to be effective and a very good record of the asset. The issues found through inspections were generally noted on the track logs accordingly.

An observation has been made regarding version control with logs with dates shown which was often different for each km. Some have/had no date or revision shown.

Inspection reporting was evident with the Track Walking Inspection Sheet being a record of a detailed walking inspection. This form was a record of the inspection observations and included some findings from the inspection. It is not clear how this information gets into work orders to get work planned and undertaken on site.

4.2 TRACK GEOMETRY RECORDING

It is understood the KiwiRail EM.80 Track Evaluation Car runs annually with reports provided to DR. The results of the most recent recording runs have not been interrogated in detail but will be used for planning and priority purposes.

4.3 ENGINEERING MANGEMENT

There was evidence that engineering management was in place where issues were noted and these included;

- Slump being monitored and recorded near 13.75 km
- Rock falls being monitored
- Tunnels had crack measuring systems in place

5 Maintenance and Renewal Strategy

Based on the inspection undertaken Vitruvius will develop a detailed strategy for the route after agreeing high level requirements and principles with the stakeholders.

An overview of a likely strategy to allow the railway to operate has been done and will consider the following;

5.1 GEOPGRAPHICAL BOUNDARIES

This route will be split as follows to allow planning around seasonal demand;

1. 4km to Hindon (26.5 km)
2. Hindon (26.5 km) to Pukerangi (45 km)
3. Pukerangi (45 km) to Middlemarch (64 km)

5.2 RAIL

The rail is predominately 70 lb/yd but in reasonable condition as detailed in section 4.1.

Although the rail is old it remains functional for the current operating requirements. A strategy for continued use would include;

- Continue measuring and recording rail wear
- Maintain fishplates and joints to limit the damage caused through wheel impact
- Be vigilant when inspecting joints for wheel flange contact with fishplates
- Continue to monitor rail corrosion in tunnels and replace rail when required

The replacement of medium weight, 70 lb/yd rail with heavy weight, 91lb/yd rail depends on the sleeper fastening type and condition of the top of the sleeper.

Where 70 lb bedplates are used then positioning 91lb bedplates would need careful consideration of existing and proposed new screwspike positions. If there are too many holes in the sleeper it become weakened through the rail seat area and could fail under load.

Complete re-sleeper and rerail could be considered through tunnels but rolling stock clearances must be assessed.

5.3 SLEEPERS

There are in the order of 85,000 sleepers in the Railway and include track, tunnels and bridges.
Track sector 1 which is currently operating has 32,000 sleepers of which it is assessed 40% are hardwoods. Many joints have good sleepers either side in what is commonly termed the joint and yard sleepers. This means four sleepers at each joint could be in better condition than other surrounding sleepers.
There is a significant amount of mixed sleeper types and newer sleepers spotted into older sleepers.
Many sections have ad hoc sleeper replacement with newer sleepers. A viable strategy for sleeper replacement is shown in the table below.

Curve Radius	Spot %	Fastenings	Sleeper Type
Up to 400 m	50	Bedplate, N, R	New
400 m and 1000 m	25	Bedplate, N	SH
Above 1000 m and tangent	25	Bedplate, N	SH

Many sleepers are observered to be close to or beyond their usable life and need to be replaced. While this is more prevalent in sector 3 from Pukerangi to Middlemarch there are life expired sleepers throughout the railway.

5.4 FASTENINGS

Fastenings are needed to hold the rail effectively and safely onto the bedplates or sleepers. Where the sleepers are close to being life expired, decayed or otherwise in poor condition the fastenings are not performing as required.
When sleepers are replaced then so are the fastenings. The sleeper replacement strategy will also manage fastening effectiveness for those sleepers replaced.
There could be sections where fastenings are loose but could become more effective through cross-boring the sleeper, using Vortok coils to provide improved fastening security or other processes that can be discussed further with DR.
Track sections that have poor and/or ineffective fastenings and cannot be made more effective would need re-sleepering in order provide rail security. This can be done as per section 5.2

5.5 BALLAST

While the was a lot of ballast consisting of river run, shingle or pit run the track geometry was being managed and the ballast was not fouled.

Any new face re-sleepering requires new ballast under and around the sleepers.

Medium axle loads and current train speeds does allow ballast depth under the sleepers to be say 200 mm depth.

Shingle and pit run are typical ballast types where manual track geometry correction is undertaken e.g. measure shovel packing. It is more usual for railways to use angular aggregates with many broken faces that lock into position when vibrated by mechanical tamping. This provides good voids to allow water to run through and not get trapped in the ballast layer.

The DR owned hi-rail excavator has a tamper head attachment and also have a mini tamper. This equipment can be used to tamp ballast during re-sleepering and other usual track geometry correction.

For Sector 2 there would need to be some actions before operating trains;

- Keeping sheep and goats out of the railway corridor
- Improving the edge of embankments and reinstating ballast shoulders

5.6 FORMATION AND DRAINAGE

The railway formation was generally in good condition.
As the railway is constructed through many cuttings the drainage is often restricted by debris from adjacent cutting faces. This will be an ongoing issue and difficult to manage. As much of the formation in these situations are rock the track formation remains sound. Regular maintenance and keeping culverts clear will assist with maintaining the track.
There were several sites that had slips or other debris come down onto the track. These are often caused through water flows on the top of cuttings and these need to be managed to control or divert the water flow.

Also refer to section 5.7

5.7 CULVERTS

The total number of culverts is unknown but could be made available.

The culvert list needs to be incorporated into the overall inspection schedule and any work required recorded so work required can be planned.

All culverts that are under embankments must be checked and analysed according to an established risk assessment. DCC are likely to have an established risk assessment framework that could be adapted for DR.

- Culverts take stormwater and/or ground water from one side of the railway to the other and into adjacent water courses
- The catchment area for each culvert will vary but culvert size can be assessed for suitability
- The risk of culverts under embankments being blocked with debris are high where forestry activity occurs in adjacent properties
- These culverts must remain clear and open to allow full capacity during rainfall events

The cost for culvert inspection and maintenance will vary considerably due to the location of each culvert.

Any culvert accessible from the track could be flushed out and debris cleared from inlet and outlet using suitable equipment. i.e. hi-rail excavator

5.8 VEGETATION

The management of trackside vegetation is an ongoing issue for Railways.
DR have inhouse staff that are certified to apply vegetation controls i.e. weed sprays. This will control vegetation and weed growth in the railway track and formation area but the trackside vegetation requires control mechanisms.
Ideally having a hi-railed scrub cutting machine available at certain times of each year would be the main maintenance objective.
This type of equipment is generally contracted by KiwiRail so that would be a constraint to availability.
Some areas around road crossings could have vegetation cleared by road equipment to provide the required viewlines.

5.9 LEVEL CROSSINGS

As detailed in section 2.1.8 each level crossing requires some form of agreement with the appropriate authority.

This agreement would include responsibility for track maintenance through the crossing, provision of signage to warn road users of the level crossing, providing and maintaining suitable viewlines and other appropriate items. Maintaining flangeways during the low or off peak train service period needs to be included in maintenance planning schedules.

It is appreciated that the RCA could be DCC

5.10 GENERAL COMMENTARY ON THE FOLLOWING ITEMS

Track geometry

- Cant of the track does not match the line speed and hence too much cant is established. Difficult to lower cant (need a tamper) but it does cause excess low leg rail head flattening and rail flow towards to field side
- Curves are well defined with run in/out of the cant in transition curves

6 Infrastructure Standards

This Railway does have operational and asset standards but these documents were not viewed or reviewed as a part of the process or strategic development. These will be used to determine the minimum standard when determining the Principal Requirements.

Vitruvius can assist DR with the development and updating of standards as required. This matter can be discussed in conjunction with the development of a strategic plan.

7 Options for Consideration

The railway is relatively old, constructed during the late 1800's but still being operated.

The issues that caused the railway into moth balling in 2020 need to be overcome through a strategic approach that meets customer demand. As local and international tourist numbers increase so does the demand for an iconic rail journey on the TGR.

7.1 RESOURCE DEMANDS

When the maintenance and renewal strategy is developed this leads to the matter of how this work can be undertaken effectively. There are many considerations including;

- In house labour for inspections and doing physical works
- Supply of Plant and equipment
- Material supply
- Contracting resources

All of these items have an influence on budget demands and are difficult to determine without knowledge of current resources and hence costs.

Working with stakeholders and suitable technical advisors would enable a budget to be developed to meet operating requirements over the next 10 years.

Budgets can be phased as resources and demands increase over time. As a starting point using existing forecast models would be an efficient process.

7.2 PRODUCTIVITY

All four items listed in section 7.1 affect productivity.

The railway is generally remote and hence access by rail vehicles is necessary to undertake work. This includes material supply to site, plant and equipment required for site works and suitable storage location for materials near to each site.

7.3 MATERIAL SUPPLY

Supplies of second hand rail and fastenings would primarily be through KiwiRail. Obviously it is vital to have and maintain suitable relationships with appropriate people within KiwiRail for purchasing second hand materials.

Some new materials would be available e.g. screwspikes and sleepers.

Sourcing suitable timber sleepers is currently being done and while this procurement needs to continue there is almost certainly going to be price escalation. DCC procurement could possibly assist with obtaining new sleepers.

7.4 BUDGET FORECAST

To provide a suitable budget forecast the demand for work to be undertaken needs to be determined and agreed.

It is not totally clear how the current Master 10 year plan for expenditure was developed but Vitruvius and Holmes can work with DR to review and revise where required to provide a budget forecast to allow a business plan to be completed.

The forecast demands can be developed and checked through the following process;

- Assess the maintenance and renewal demands for the three sections phased over the three periods as detailed in Section 1
- Assign priorities and costs against those demands
- Develop a strategy that includes a phased increase in resource requirements

Understanding the base costs for the usual operation of the railway and also the upgrade or renewal costs are important.

A cost model could be constructed using the following base assumptions;

- 40% of track staff time is spent doing inspections and usual maintenance activity
- 5% of track staff time is spent doing callouts and emergency track inspections

This would result in say 50% of time available for upgrade and renewals work.

Resource demands can be established for upgrade or renewal work activities when considering sections 7.1 and 7.2.

8 Conclusion

The railway route from WIngatui through to Middlemarch is an iconic railway trip and an opportunity for the South Island tourism industry. As with any railway there are cost implications for the infrastructure that may or may not be able to be funded through direct income sources.

DCC have commissioned Vitruvius through a RFQ to provide;

- A condition assessment for the track and structures
- A schedule of works

Current track inspection processes are identifying issues with the track, formation, drainage and related assets. Track inspection findings are recorded on appropriate forms

Issues found during inspections have been noted on the track logs.

8.1 CONDITION ASSESSMENT

From the inspection undertaken by Vitruvius and the evidence presented it can be determined that inspection processes are being undertaken and the recorded results reflect the track condition. It should be noted that the completeness and frequency of these inspections has not been audited against the operating standards.

It would be appropriate to discuss the findings from the inspection undertaken by Vitruvius with appropriate DR personnel. From this discussion the current condition can be assessed and agreed based on DR expectations, risk and current operational capability.

8.2 SCHEDULE OF WORKS

As detailed in Section 7 there are many considerations and factors that affect work required and costs to undertake that work.

Refer to section 7.4

A schedule of works can be developed in conjunction with appropriate DR personnel.

Refer to section 9

9 Recommendation

It is recommended the following be considered and discussed further;

1. Vitruvius to discuss inspection findings with the appropriate people in DR to present an agreed position and collaborative response to the RFQ.
2. The individuals involved hold more discussions with front line staff to determine a viable and deliverable renewal strategy.
3. Vitruvius, DCC and DR work together to agree the phasing of the upgrade works
4. A schedule of work based activities is developed in the form of a work bank structure for costing and planning principles
5. Confirm the financial implications of extending the current train service beyond Hindon
6. Develop and agree the 10 year budget forecast for maintaining and upgrading the railway and delivering an agreed level of service
7. Review the inspection > review > plan for work process
8. Discuss the current condition ratings and priorities for track assets and address any inspection requirements or engineering management plans
9. Review current asset condition and assess against standards to determine if the activity is delivering a safe passenger service base

Appendix

A

Heading

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A.1

Appendix

B

Heading

B.1

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