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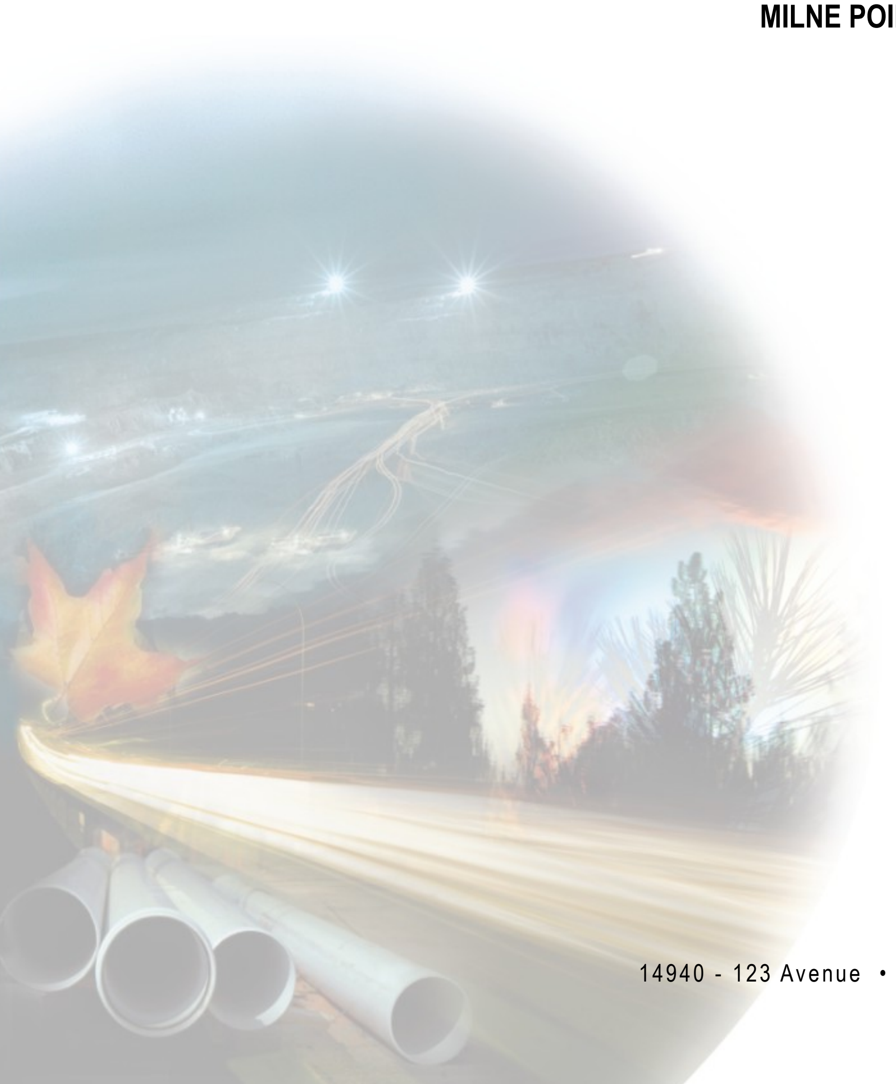
Baffinland Iron Mines Corporation

ISSUED FOR REVIEW

BORROW SITE RECLAMATION OVERVIEW
MILNE POINT ACCESS ROAD, MARY RIVER PROJECT
BAFFIN ISLAND, NU

E14101074

December 2009



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EXECUTIVE SUMMARY

This report documents a reconnaissance trip by D.W. Hayley, P.Eng., in July 2009 to examine the condition of borrow pits along the 100 km long tote road from Mary River Camp to Milne Inlet on North Baffin Island. The purpose was to develop objectives and practical guidelines for planning reclamation of the pits. Field notes supplemented with a photo library provided a basis for a summary of findings at 81 sites provided in a table in the report.

Two principal issues must guide the reclamation effort:

- Protect ground ice within the permafrost from future thaw that can destabilize both the terrain and the road embankment.
- Establish drainage in those pits that have formed ponds that are judged to be detrimental to terrain stability.

The 81 pits have been grouped into Priorities A, B, and C in the Summary Table. The Priority A pits are those where active thaw of ground ice is affecting not only the pit but also the adjacent road. These pits should be the first to receive attention as they constitute a safety hazard for continued use of the road. Priority B pits are those where active thaw and sinkhole formation is ongoing. These are not currently affecting the road but are trapping surface runoff. The Priority C pits are those where the terrain has been judged to be relatively stable. They will require some site grading and surface dressing, but the timing is not as significant.

The 81 pits are distributed into three groups as follows:

- Priority A: 8 pits (9%)
- Priority B: 25 pits (31%)
- Priority C: 48 pits (60%)

It is estimated that 10 to 15 pits `were not documented during the reconnaissance. They can all be considered to fall in the Priority C grouping.

The principle recommendations for reclamation of the pits include:

- Strategic placement of new embankment material on and adjacent to the road fill in those areas where on-going thaw is threatening the road as well as the surrounding terrain.
- Placement of new cover or regarding the surfaces to cover exposed ground ice within pit bases.
- Develop new gravity drainage from those pits where pond formation is affecting permafrost and threatening to initiate erosion that could result in damage to surrounding tundra.

Planning the reclamation effort should anticipate that it may take several years of regrading, fill placement, monitoring, and adaptation to achieve an acceptable long-term condition. This must be done carefully to minimize the risk that further work within the pits could expose new ground ice.

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1.0 INTRODUCTION

1.1 BACKGROUND

An access road was constructed to connect the Mary River Camp to tidewater at Milne Inlet on Baffin Island from August 2007 to October 2008. The purpose of the road was to provide a route for trucks to haul a bulk sample of the iron ore from the Mary River deposit to a port site at Milne Inlet, a distance of about 100 km. The road design and construction are described in a comprehensive as-built report by Knight Piésold Consulting, entitled "Milne Inlet Tote Road Construction Summary," dated February 5, 2009.

The road follows an original overland access route from the 1960s. The road is not considered part of future overall mine operations, but it may be required to mobilize equipment and supplies to the mine site during the development phase. It is therefore considered temporary infrastructure that will be decommissioned and abandoned in the near future. Baffinland Iron Mines Corporation would like to proceed with progressive reclamation as early as practical. This report provides guidance on reclaiming soil and rock borrow pits that were developed for sources of embankment material along the route. Reclamation of those sites must proceed while the road remains trafficable.

1.2 PURPOSE AND SCOPE

This project was structured to provide a basis for planning reclamation and abandonment of the pits along the tote road. This requires an understanding of the roles that soil conditions, permafrost, ground ice, and water will have on the medium- and long-term stability of the terrain following reclamation activities. The recommendations were developed from observations during a route reconnaissance in mid-July 2009. They represent experienced judgement of the site conditions at the various pits.

The scope of the study included the following:

- Develop generally accepted criteria for physical reclamation of sites where material was excavated for road construction;
- Identify the primary factors that must be addressed during planning and implementing the borrow pit reclamation program;
- Visit and document conditions at sites along the route;
- Develop concept-level reclamation recommendations; and
- Prepare a report with guidance appropriate for planning the reclamation activities.

The study was limited to those factors that must be addressed to prevent degradation of the landscape and establish physical stability over the long term. The ability of the landscape to return to biological productivity has not been addressed with this study. The paramount consideration when returning arctic sites to productive landscape must always be to first address any ongoing physical degradation from permafrost thaw or erosion by abnormal runoff conditions.

2.0 RECLAMATION OBJECTIVES

2.1 GENERALLY ACCEPTED REQUIREMENTS

There are generally accepted guidelines or practices for reclaiming pits and quarries in an arctic environment. The most universally used guide in Northern Canada was developed for Indian and Northern Affairs Canada (INAC) under the "Arctic Land Use Research Program" by MacLaren Plansearch Ltd. (1989), entitled "Environmental Guidelines, Pits and Quarries". The document has been used extensively for planning pit development and reclamation in the Mackenzie Valley and elsewhere throughout the Northwest Territories.

INAC has been working on a new guide for the Canadian arctic, currently in draft form, entitled, "Northern Land Use Guidelines, Pits and Quarries", October 2008 (Draft), which is available for review by practitioners. These new guidelines are less specific than the original guide and somewhat more process oriented. The section on reclamation provides information on when it may be acceptable to leave a lake within a pit, how to use topsoil as cover material, and how to promote revegetation of stripped surfaces. It also clearly identifies the need to ensure long-term pit drainage.

The Mary River tote road pits currently have many sites without established drainage. Ponds have formed at a number of sites that have no obvious means for establishing gravity drainage. Some of those ponds may be permanent fixtures on the landscape. Topsoil is thin or non-existent so its replacement coupled with revegetation is not a practical (or even a possible) option for the pits in this region. The overarching issues for planning the reclamation program will be establishing pit drainage without initiating new degradation of the permafrost and stabilizing ice-rich permafrost soils that are now thawing and resulting in ever-increasing sinkholes.

2.2 REQUIREMENTS OF THE LANDOWNER

Most or all of the land crossed by the tote road is within Inuit Owned Lands as granted by the Nunavut Land Claims. The Inuit Owned Lands in this region are administered by the Qikiqtani Inuit Association (QIA), Department of Lands and Resources. The QIA have published an "Abandonment and Reclamation Policy" for Inuit Owned Lands. That policy, Version 3, 2008, has a list of reclamation goals and obligations to be met by the land user. For the purposes of this study, the writer has extracted those that would clearly apply to the tote road borrow pits developed by Baffinland on QIA land as follows:

- Reclamation should achieve a site that is physically, chemically, and biologically stable upon closure.
- Reclamation should result in a site that is aesthetically and environmentally compatible with the surrounding undisturbed landscape.

- Land users should employ international best practices for arctic conditions as well as federal and territorial legislation, regulations, and guidelines.
- Land users may be required to undertake post-activity monitoring.

The writer has an extensive background with road construction on permafrost terrain, including planning construction material source development and reclamation practices in arctic regions of Canada, Alaska, Russia, and Svalbard (Norway). That experience base has been used to interpret and apply the criteria and guidance identified in the above documents to provide practical guidance for pit reclamation on the tote road.

2.3 THE ROLE OF OBSERVATION AND MONITORING

Terrain stability can seldom be achieved on disturbed permafrost terrain in a single season. Two or more staged seasons are usually required to complete reclamation of those pits where thaw of ground ice is most prevalent. This will require that site observations and simple monitoring of terrain response to reclamation efforts be included in any reclamation plan. Monitoring can comprise a systematic set of observations of the pits twice per year (early summer and late summer) with some limited surveying to check site grading where it is important to prevent pond formation. The site observations and monitoring data will provide a basis for optimizing reclamation efforts for that year.

3.0 BORROW PIT ASSESSMENT

3.1 ROUTE RECONNAISSANCE PROCESSES

Pit observations were obtained from July 20 to 23, 2009. The writer worked together with Jeff Bush, of Baffinland Iron Mines, to observe and make notes at 81 sites where material was removed from the tundra for road grade construction. Mr. Bush provided information on the history of the road construction and details on its performance and maintenance issues. The initial phase was an aerial reconnaissance by helicopter followed by two days of ground reconnaissance by truck. Excellent weather throughout the reconnaissance period provided the opportunity to collect a clear photographic record to supplement the site observations. All the sites and photographs have been tagged using handheld GPS for accurate location on maps included in this report. Most sites are included in our inventory of 81 locations. Those that are not included can be considered of minor consequence and require the minimum of reclamation work as described later in this report.

Road construction was initially carried out by excavation of fill material from three regions where pit development permits were obtained off the 30 m wide permitted right-of-way (ROW). These sites were at each end and at the midpoint and are generally known as Mary River Pit, Mid Point Pit, and Milne Pit. When long haul distance was adversely affecting construction productivity, material was excavated from the active layer soils at random locations along the route corridor. These sites were confined to the ROW width; therefore, in many locations they are contiguous with the edge of the road embankment.

The active layer soils were excavated in summer for embankment construction at more than 80 locations. This left the underlying permafrost soils exposed to thaw over a substantial cumulative surface area that constitutes the route ROW.

The sites have been identified by kilometre post following the survey and map sheets included in the as-constructed report prepared by Knight Piésold Consulting (February 2009). The route chainage begins at Milne Inlet (km 0), which is the northern terminus, and progresses south to the trial pit at KP 109. The Mary River Camp and airstrip is located at KP 100. Each soil borrow site was tagged using handheld GPS. The site numbers begin near the camp as Waypoint No. 8 (km 98.3) and terminate near Milne Inlet at Waypoint No. 87 (km 2.9). The waypoint numbering system is opposite to the chainage as the ground reconnaissance was conducted by vehicle working from the Mary River Camp. A final site, Waypoint No. 88 (KP 104.4), is located on the road between the Mary River Camp and the bulk sample mine. The 81 sites where notes were made and photos were taken were transcribed onto a map set showing the alignment provided by Knight Piésold, and this map set is included in Appendix A. The site waypoints were converted to road chainage following the original alignment convention in the Summary Table at the end of the text. Those site chainages matched the chainage signage in place on the tote road at the time of the reconnaissance.

3.2 OVERVIEW OF RECLAMATION ISSUES

3.2.1 Permafrost and Ground Ice

The Mary River Camp is located in North Central Baffin Island. The closest community is Pond Inlet, on the coast about 150 km north of the camp. The normal mean annual air temperature reported for Pond Inlet is -15ºC (1971–2000 Canadian Climate Normals). The cold climate sustains continuous permafrost throughout Northern Baffin Island with ground temperatures anticipated to be -8ºC to -10ºC along the route. The tote road routing follows glacial valleys that have been infilled with granular material that varies in texture from silty sand to sandy gravel with cobbles and some boulders. Most of the deposits are either post-glacial river terraces or proglacial lacustrine basins. The lake basin segments are table-top flat with finer grained silt and fine sand prevalent. The terrace-like features are poorly sorted (dirty) gravels. The active layer is expected to be thin in the lake sediments (less than 0.5 m) whereas the higher, well-drained terraces could support an active layer of 1.5 m or more. No definitive information is available to confirm those estimates of active layer depth.

Ground ice occurs throughout the region in the upper permafrost soils as predominantly:

- segregated ice (horizontal lenses),
- wedge ice (vertical crevasses of ice), or
- massive ice (tabular bodies).

The wedge ice is the most striking feature in the region of naturally well-drained granular uplands. These show up in aerial oblique photos, such as Photo 1,[1] as polygonal patterned ground comprising a series of orthogonal cracks that are the surface expression of ice wedges that occur to depths up to 3 m into the permafrost. These ice wedge features formed over a period of 8,000 or so following deglaciation by perennial rapid thermal contraction followed by water infiltration and frost heave expansion. They can be up to 1 m wide at the top of permafrost and taper with depth in a carrot-like shape. They are a common feature of granular permafrost soils as these frozen soils behave in a brittle fashion when subjected to rapid drop in air temperature leading up to winter.

Wedge ice that is exposed at the surface within the pits after the thawed active layer soils have been removed in summer will begin to thaw from the top down, resulting in a linear depression such as shown in Photo 2. The thaw-depression will typically trap water that now becomes mobile, running along the top of the ice. These features commonly extend under the road embankment. The thaw initiating within the adjacent pit will feed water into the ice wedge under the road embankment resulting in thermal erosion that frequently leaves a transverse void below the road. When this happens below a road that is in service, the expanding void can precipitate catastrophic failure of the embankment, which is a substantial concern to safety of any operations over the road. This mechanism of wedge ice feeding water into cavities that extend under the road is the cause of a number of imminent road collapses that were observed during the route reconnaissance such as the site shown in Photo 2.

Segregated ice occurs as thin lenses in all the finer grained silty soils. It is most prominent in soils of glaciolacustrine origin. The ground ice distribution is erratic, but it is commonly found with greater concentrations in naturally wet basins. When these soils are exposed within the pit bottom, the consequences are sinkhole depressions that soon become water-filled, interrupting any natural surface drainage. An example of a pit floor affected by melt out of segregated ice is shown in Photo 3. Pit backslope soils with segregated ice exposed will slough or run downslope during summer thaw. That was not a common observation during the reconnaissance; most of the relatively steep backslopes were noted as stable.

Massive ice was identified at only one pit location (km 63.7). An exposure of the remains of massive ice is shown in Photo 4. Massive ice is generally large tabular bodies of ground ice. They have been attributed to either regions of groundwater discharge or buried ancient glacial ice. The ice feature in Figure 4 is in the pit shown in Photo 5, which is adjacent to a natural drainage channel within a gravel deposit (alluvial terrace). The ice could be from either source. Massive ice is anticipated to be more prevalent along the ROW than suggested by the single location where it was actually observed.

Both massive ice and wedge ice must be protected from retrogressive thaw by replacing the stripped active layer soils with an appropriate new cover to arrest further thaw and settlement that can carry on for decades.

[1] All photos referenced within the text are included in the attached Photographs section.

3.2.2 Runoff Management

The silty and sandy texture of the soils along the route makes them particularly susceptible to erosion and downslope transport by surface water. The short intense freshet period each spring occurs when the active layer soils are mostly frozen, thus the proportion that runs off is very high (often expressed as a runoff coefficient near unity). Emphasis should be placed on ensuring that soil transport by erosion and sedimentation does not affect undisturbed tundra that lies downslope from the borrow pits. Managing runoff from the disturbed areas within each pit must therefore be an important part of the reclamation plan.

The route reconnaissance identified those pits that are poorly drained or are on slopes where rapid release of outflow could affect the surrounding undisturbed tundra. That may be from trapped surface water, melting ground ice, or high gradient that can initiate and sustain erosion.

3.3 SITE SUMMARY AND GROUPING

A summary of the conditions noted at each of the 81 sites is included at the end of the report in Table 1. The sites have been grouped into three broad categories that reflect the reclamation criteria discussed in Section 2.2:

- Priority A pits – where thaw-settlement initiated by pit excavation is actively affecting the road integrity and safety,
- Priority B pits – where active thaw settlement and water accumulation is ongoing in unstable terrain within an abandoned pit, and
- Priority C pits – are relatively stable but will need reclamation attention to improve site aesthetics and ensure long-term stability.

The distribution of site types is as follows:

- 8 Priority A (9%),
- 25 Priority B (31%), and
- 48 Priority C (60%)

Perhaps as many as 10 to 15 sites are not on the list. They are generally small, shallow depressions where limited material was removed. They can be considered as Priority C.

A detailed photographic record from the route reconnaissance was prepared and is included as a DVD appendix to the report. The photos taken during the aerial reconnaissance phase range from numbers DWH 557 to 674, and the ground reconnaissance photos range from DWH 675 to 734. The photo locations by number are shown on the route maps, Appendix A. The geographic locations of the photos are included in their jpeg file information. The photos have been linked to the various sites in the Summary Table. These constitute a useful reference of the condition of the pits at the time of the reconnaissance.

4.0 RECLAMATION METHODS

The Summary Table includes a brief comment for each site on where the reclamation focus should be and is followed by more detailed comments on suggested processes to follow. The reclamation process should be structured around the basic principles of:

- Restoring stability to actively thawing ground ice by replacing some of the cover material removed during excavation;
- Developing drainage that will limit standing water that can exacerbate thaw within the pit;
- Caring for natural runoff from the pits in a manner that will reduce the risk of erosion and sedimentation over undisturbed tundra; and
- Improving site topography to encourage natural revegetation and enhance site aesthetics.

The sites identified as Priority C are the least sensitive and can generally be reclaimed by site grading and dressing of the slopes. A typical Priority C site is shown in Photo 7 (attached). The Priority A and B sites are judged as not currently stable and therefore will require attention directed to the ongoing thaw of permafrost and surface water management. The following discussion provides guidance for planning reclamation that that will address these objectives.

4.1 RESTORE SURFACE STABILITY

The Priority A pits are experiencing ground ice melt out that is affecting the adjacent road embankment. Past experience has shown that the consequences can be a serious safety hazard. It is recommended that the road embankment be upgraded at these sites on a first priority basis. The upgrading will require strategic placement of granular cover over the thawing soil with the ultimate purpose of drawing the permafrost back up into the fill. The steps for reclamation should include the following:

- Construction of side berms a minimum of 3 m wide on the road shoulders where active cracking and settlement is observed. The berms should be a minimum of 1.5 m thick and also to an elevation above any possibility of being overtopped by ponded water in the future. It is also preferable for them to be at an elevation 1 to 1.5 m below the final top of road fill at the location.
- Add material to raise the embankment height. Suggested final fill height increases at the various sites is included in Table 1. The height increase should be a minimum of 1 m, and in some cases, 1.5 m to 2 m is suggested.
- Improve drainage such that water does not pond at the toe of the embankment. In some cases this may require filling sinkholes and ice wedge melt-out features with imported gravel.

An alternative to berm construction for sites where the thaw has not yet progressed under the road embankment but is affecting the sideslopes is to widen the grade and flatten the sideslopes. The current road shoulder should be widened 0.5 m to 1 m and the slope flattened to 4 H to 1V. The Summary Table provides guidance on those sites where slope flattening is an option. They include many of the Priority B sites. Where slope flattening is applied, consideration should be given to the extent that water can continue to pond at the toe of the slope. One of the primary benefits to be gained from slope flattening is to push the risk of ponded water further from the embankment slope.

Some Type A and B sites have developed substantial sinkholes within their pit bottoms. Where these have been observed, regrading the surface to fill the sinkholes has been recommended. In some cases, this may require importing fill from another nearby site that is still active and can confidently produce material without exposing new wedge ice. Those sites are identified in the Summary Table.

4.2 DRAINAGE IMPROVEMENTS AND EROSION PREVENTION

Ponded water within the borrow pits retards winter freeze-back of the active layer and will result in retrogressive thickening of the active layer. Once this process starts, it is difficult to reverse. Shallow ponding (less than 0.5 m deep) that is short-lived following freshet is not a particular concern. Those ponds that are retained throughout the summer and continue to deepen with time will be counter-productive to the reclamation efforts.

The Summary Table identifies a number of options for improving site drainage at specific pits. In most cases, there is an obvious routing for trapped surface water from the pit to a nearby stream or onto the tundra. In some cases, it will be necessary to install a new culvert under the road embankment. Some pits are identified in the table where additional field work will be required to determine the drainage improvement options for those sites. This will probably involve site surveys to establish the natural topographic grades or if there are options that involve minor ditching.

Substantial ditch excavation into undisturbed active layer soils should be avoided wherever practical. Where new ditching is the only practical option, care should be taken to determine the nature of soils and ground ice that will remain exposed following excavation.

In cases where surface water will be directed to undisturbed tundra, it must be dissipated rather than channelled to avoid local erosion. Dissipation can be achieved by strategic use of cobbles and boulders to dissipate energy just before the water exits the pit area.

4.3 SURFACE GRADING

All the pits will require surface grading that will range from filling sinkholes in the Priority A and B pits to simply dressing the current surface in most Priority C pits. Obvious ridges that can impede surface drainage should be removed and final surface contour developed to ensure drainage. The surface should not be left completely smooth. It is common practice at the end of surface grading to track the surface with tractor grouser bar ruts. These will trap fines and dissipate energy from runoff. The shallow grooves left in this manner will also improve the possibility for long-term natural revegetation by providing seed traps.

The backslopes on the pits are remarkably stable, typically like those in Photo 8. Those steep slopes greater than 2 m in height should be graded to a final slope of 3 H to 1V. It is preferable to flatten the slopes by mounding new fill at the toe rather than cutting further into undisturbed tundra. The steeper pit slopes observed were generally of a height less than 2 m and were not visibly active. These shallow cut slopes that are currently stable are better left to seek their own long-term condition rather than risk further disturbance to the underlying permafrost.

5.0 CONCLUSIONS

The focus of this project has been to develop general guidelines for developing a practical and acceptable plan for reclamation of the borrow pits. This plan can form the basis for estimating construction effort and developing a schedule. The site observations have established that there is a clear link between some borrow pit locations adjacent to the road with the present and future operation of the road. In some cases, disturbance caused by pit excavation is affecting the road integrity and its safety. It is therefore necessary to deal with those Priority A pits and the adjacent road on a priority basis.

The construction material demand for the next few years of road operations before decommissioning should be established. The demand can be satisfied from a few select pits. Those pits that will remain in service until reclamation and abandonment of the road should be carefully evaluated and a plan prepared for their future use and their ultimate reclamation. Several of the pits can effectively provide material for maintenance purposes and have been identified in the Summary Table.

The photo library and documentation in this report provide a basis for monitoring changes and adapting the reclamation process in a step-wise manner. The Priority A pits should be addressed first with attention to the Priority B pits as early as practical. The Priority C pits will not change significantly if left for a few years. It is suggested that a number of the Priority B pits be selected for the first stage of reclamation during the summer of 2010. That should include drainage improvements and strategic placement of granular cover in those locations experiencing active thaw. These measures can then be observed over the following year and adjustments to the process made to minimize use of new material for reclamation. Where new gravel cover is necessary for protection of the permafrost, care must be taken to ensure it is harvested at a location that does not contribute to further degradation of the permafrost.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Baffinland Iron Mines Corporation and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Baffinland Iron Mines Corporation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's General Conditions are provided in Appendix C of this report.

7.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

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TABLE

TABLE 1: SUMMARY OF PIT OBSERVATIONS AND CLOSURE RECOMMENDATIONS											
Site WP No.	**Km Post**	**General Location Comments**	**Pit Water**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**Ground Photos**	**Aerial Oblique Photos**	**Closure Comments**
8	98.3	Off ROW permitted	Minor ponding	Low	Abundant wedge ice	Fair	Drainage improvements	C		557, 558	This pit is within off ROW permitted and should be regraded and closed with future material taken from Area 1.1
9	97.9	Off ROW permitted	Minor ponding		Extensive wedge ice	Fair	Regrading surface and slope	B		559, 560	This pit within permit area should be reclaimed. Pad and flatten south slope of road to limit further thaw of wedges and erosion. Improve drainage without further impact on natural tundra wedge ice lying to the south of disturbed area.
10	97.5	Off ROW permitted	Major ponding	Low	Massive ice	Unstable, extensive thaw occuring	Pump out ponds, berm road sideslope on south side such that no water can pond at toe. Regrade pit bottom	B	675	561	Pit is still within quarry permit area but should be reclaimed soon. Extensive thaw settlement is occuring. Future materials should be taken from source 11.
11	97.3	Off ROW permitted	Major ponding	Low	Wedge ice	Moderately stable	Improve natural drainage and develop a plan for an ongoing pit at this location	C	676	562	This is currently the best source of gravel in the vicinity of Mary River Camp. It is permitted for development off the ROW, and the material is relatively well-graded alluvial gravel. This pit has ongoing value for the development. A pit development plan should be prepared that will allow efficient stockpiling of the material in a manner that deals with surface water and thaw generated water. The plan should include site reclamation.
12	93.2		Runoff impounded	Severe	Unknown	Unknown	Culvert needed	A	677		The road crosses a natural valley at this site, and water is trapped against the upstream road embankment. The pond must be drained by culvert installation to prevent thaw and collapse of the embankment and risk of significant downstream erosion. The disturbance from scavenging active layer material on ROW is minor at this site.
13	92.7		Runoff impounded	Moderate	Unknown	Unknown	Culvert replacement/repairs needed	A			This site has a drainage interruption issue that needs attention. Not a soil borrow site.
14	89.8		Substantial	Moderate	Unknown	Unstable	Pit directly adjacent to south toe of road embankment. Ponding threatens to undermine road	B	678		The active layer was pushed up to form the embankment at this site. Substantial ponding is present in disturbed area. Site needs to be regraded and drainage established to the south where a new culvert can be installed that will lead to a natural drainage course.
15	87.8		Moderate	Moderate	Substantial segregated ice throughout silty material	Unstable	Improve drainage along the south embankment sideslope convey ponded water to the existing culverts	B		567	Material exposed at this site is predominantly silt. Thaw-subsidence will continue. The strategy for reclamation must be to improve drainage using existing culverts and continue to regrade the surface until the active layer stabilizes. Keep ponded water from accumulating against the toe of the embankment. The exposed silt at this site is very mobile; thus, erosion protection measures may be required when improving site grading.
16	86.2		Moderate	Severe	Minor	Stable	Long-term drainage improvements	B	679		This is a deep pit pond that has established on the south side of the road. Soils in this area are controlled by a weak carbonate sandstone that readily decomposes into fine uniform sand. The pond is currently functioning as an effective sedimentation pond. Water is clear and the pond seems to be stable in a region of minor thaw-subsidence. It is recommended that the pond remain and that a new and higher culvert be placed through the road to allow the surface water to drain into the creek and subsiquently the lake. The road embankment should be raised a minimun of 1.5 m at this location to protect the permafrost and provide cover for the new culvert.
17	75.0		Not practical	Low	Not apparent	Stable	Surface dressing and erosion protection	C	681, 682	580	This is a long section where the active layer soils have been pushed up from both sides to form the embankment. South (left) side is dry and stable — surface dressing only required. The North (right) side has a deep pond (Photo 681). The surrounding terrain is flat thus little oportunity for natural drainage. The ponds are not affecting the embankment, and ground ice seems minimal. The ponds can be left following site grading with some armour placed on the adjacent sideslope to prevent erosion and dusting.
18	74.7			High	Not apparent	Stable	Protect outlet at north end from erosion	B	683		Sandy active layer soils have been removed on ROW for embankment construction. Minor thaw subsidence or ponding within pit floor. Outlet for water at north end flows downhill into a creek. Substantial risk of erosion on that sandy slope during freshet. Recommend armouring the outlet with coarse materials and cross berm for erosion protection. Dress pit floor.
19	73.8		Uncertain	Moderate	Substantial wedge ice	Unstable	Protection of road sideslope	B		581, 582	This site is locally very ice rich. Water ponded along road shoulder is a threat to the road. Drainage improvement options are not obvious and should be reviewed further in the field. If ponds cannot be drained, construct a berm to an elevation above water level that will push water back 3 m from embankment slope.
20	73.4		No	Low	Not apparent	Stable	Dress pit floor	C			Small active layer pit. Dry and stable. Dress the surface.
21	73.1		No	Low	Not apparent	Stable	Potential future use	C			Top of hill, small quarry in rock. Could be a source of materials for road repair and dressing or filling sink holes in nearby pits. Can be easily reclaimed by surface grading.
22	72.4		Drain and fill all ponds within 3 m of the toe of embankment	Moderate	Wedge ice, possibly massive ice	Active sinkhole formation	Road embankment safety	A	684, 685, 686, 687	584	The pit on the north (left) side has become a large sink hole that is actively undermining the sideslope and crest of the embankment. Wedge ice appears to extend under the road, and there is a potential for water to flow through any wedge cavities. Active cracking is occuring well into the driving lane. This is a priority site for repairs. Substantial risk of a road surface collapse exists. The sinkhole pond should be either drained or pumped and the road grade raised. A berm 3 m wide should be constructed in areas of active embankment sloughing. The site should be frequently observed when the road is used for haul traffic.
23	71.8		Regrade and fill	Low	Extensive, distributed	Sinkholes active in pit floor	Regrade and fill	B	691		This site has active sinkholes below surrounding terrain. Some water trapped. May require imported fill from other sources to regrade the pit floor.
24	68.5	Communication Tower		Low	Not apparent	Stable	Flatten embankment slope by filling out into pond displacing water	C			Small water-filled pothole left following material excavation. No obvious natural drainage potential. Complete reclamation would require infilling. Nearby material sources are not obvous.
25	66.7		Clean ditch along toe of slope	Low	Not apparent	Stable	Regrade surface	C		585	Coluvial soils scavenged from hillside above road for embankment. Site is stable requires cleanup and dressing with improvements to drainage along toe of slope.

TABLE 1: SUMMARY OF PIT OBSERVATIONS AND CLOSURE RECOMMENDATIONS

Site WP No.	Km Post	General Location Comments	Pit Water	Erosion Potential	Ground Ice Features	Active Layer Stability	Reclamation Focus	Priority	Ground Photos	Aerial Oblique Photos	Closure Comments
26	65.2	Active Pit	Well drained	Low	Not apparent	Stable	Regrade surface	C	692	586	This pit remains active with reasonable construction material. Drainage is currently good, but further excavation within ROW will probably initiate ponding. Should material continue to be removed, a pit development and reclamation plan should be prepared.
27	64.7		Poorly drained	Low	Not apparent	Moderate	Fill and regrade	C			This is a small pothole filled with water. Site should be regraded and fill added to improve drainage.
28	63.9	Active Pit	Dry	Low	Not apparent	Stable	Dress surface	C			Both sides of road. Naturally well-drained silty gravel. No sinkholes. Grade surface at closure.
29	63.7			Severe	Massive ground oce observed in pit. Wedge ice under road.	Unstable, extensive thaw	Rebuild road grade	A	693, 694, 695, 696, 697, 698	587	This is the most ice rich site noted. Remnants of massive ice were found in large thaw depression on south side of road. Ice wedges are actively melting under road sideslope Cracks and depressions extend to the shoulder. To reduce risk of road collapse, the grade should be raised at least 1 m through this area and berms a minimum 3 m wide constructed on the south sideslope. Final reclamation of this site will require further assessment of the best method for ensuring drainage from the sink hole without risking siltation of the creek valley immediately to the south.
30	63.1		Dry	Low	Not apparent	Stable	Regrade	C	703	593, 653	River terrace. Active layer gravel removed over a large area. Site is dry and naturally well drained. Regrade surface for reclamation.
31	62.5	Midway Pit, Off ROW permitted	Minor ponding	Low	Wedge ice on south-facing slope	Stable	Regrade	C	706	590, 653	The active layer has been stripped over a substantial surface area. Gravel is well graded and free draining. The site can potentially produce more gravel by progressive stripping as it thaws or by drill and blast. A pit development plan including reclamation planning should be developed if borrow material harvesting is continued at this location.
32	56.9R		Moderate	High	Substantial wedge ice	Unstable	Improve site drainage	B	710	594, 595, 649	Pit excavated in ice-rich sandy gravel. Active thermokarst and ponding. Regrading to fill ponds required. Develop drainage to the east along north side of road. Construct a coarse boulder apron at outfall onto tundra.
33	56.7L		Severe	Moderate	Not visible	Unknown	Drainage enhancement	B		594, 595, 649	Pit water is intended to drain to a small culvert under road at west end of pit. Continued settlement has left invert of culvert too high. Consider draining along north (left) toe of road grade to natural draw about 100 m south and placing a new culvert through road at that location. Consult Photo 649.
34	55.8		Minor	Low	Not apparent	Unknown	Grading	C			Regrade and improve drainage.
35	55.4	Risk of road collapse	None	Low	Wedge ice	Unstable	Protecting road embankment	A	711, 712	596, 597, 648	A small excavation on the upslope side of the embankment has allowed water to penetrate into Wedge Ice initiating thermal erosion. The road grade was actively collapsing into thaw depressions at the time of the visit. There is a high safety risk of total collapse. The road must be bermed on both sides for a distance of 3 to 4 m and the embankment raised to accommodate settlements that have occured. The sideslopes should be dressed along with disturbed areas. The site should be monitored during periods of high road use until stability of the permafrost is assured.
36	53.1		Minor	Low	Not apparent	Stable	Protecting road embankment	C			Small pothole pit beside road. Material stockpile. The shoulders of the road should be dressed and slopes flattened.
37	52.6	Road collapse	Dry	Low	Wedge	Unstable	Protecting road embankment	A	713, 714	598	Active sinkhole on immediate north side of embankment has extended under the road resulting in grade collapse about 1/2 m. Selective excavation of the road fill and underlying ice at this site is recommended followed by rebuilding grade with compacted material. Raise the final grade 1 m or more above current elevation and flatten sideslopes.
38			Dry	Low	Not apparent	Stable	Grading	C			Dress the slopes and bottom.
39				Low	Wedge ice extending under road	Unstable	Stabalize road surface, dress sideslopes and fill sinkholes	B			Sinkhole under road at north end, cracking onto road surface. Build road grade up, dress disturbed area, and flatten embankment sideslopes.
40		Hole in Road		Low	Wedge ice extending under road	Unstable	Ensure safety of road	A	715, 716, 717	645	Wedge Ice that extends under the road has thawed resulting in collapse. Road grade dropped about 1 m. Sinkholes in pit allow standing water adjacent to sideslope. Raise the road grade about 1 m at this location, and construct side berms to protect permafrost and push any free water 3 m minimum away from toe of slope. Regrade the abandoned pit and upgrade the site drainage.
41	50.6L		Minor	Low	Localized wedge ice	Moderately stable	Regrading	C			Regrade and improve drainage from sinkholes.
42	50.3L		Mostly dry	Low	Ice wedges, south end	Sinkholes south end	Regrading	C			Regrade to fill and cover sinkholes at south end.
43	50.0R		Dry	Low	Not apparent	Stable	Dress surfaces	C			Long pit where active layer soils have been pushed up to make embankment.
44	46.7L		Minor	Low	Not apparent	Stable	Dress surfaces	C			Pothole pit, some water. Dress slopes and improve drainage.
45	46.1		Dry	Low	Not apparent	Stable	Dress slopes	C			This is a confined but deep pit, currently dry. The backslopes are steep and may require minor cleanup and dressing.
46	44.0		Dry	Low	Not visible	Moderately stable	Repair grade	A	718, 719		This road cut exposed ground ice that is actively thawing. The road grade should be built up at this location about 1/2 m.
47	42.2R		Partial	Low	Not visible	Moderate	Regrade	C		603, 604	Small pit with one large sinkhole. Regrade and fill sinkhole — not affecting road.
48	38.0R		Dry	Low	Not visible	Stable	Regrade	C			Dry pit on ridge. Regrade to dress surfaces.
49	37.5R		Dry	Low	Not visible	Stable	Dress surface	C		605	Linear pit from pushup. Well drained. Dress the surface.
50	37.2R		Dry	Low	Not visible	Stable	Dress surface	C			Similar to 49.
51	36.5 L&R		Ponding on left	Low	Wedge Ice	Moderate	Improve drainage and regrade	B		606	Active layer removed along road on both sides. Well developed ice wedge cracks evident across pits and continuing under embankment. Beginning to affect road at north end. Stockpiles remain in left pit. Further removal of surface soils at this location not recommentded without a pit development plan. Reclamation should grade pit surface, infill ice wedge cracks and and flatten embankment sideslopes in regions showing distress. Improve drainage.
52	36.2R		Dry	Low	Not apparent	Stable	Regrade	C			A relatively large pit but dry and stable bottom. Dress slopes and bottom.
53	35.5		Dry	Low	Not visible	Moderately stable	Regrade and fill sinkholes	C			Long, linear pit with a few sinkholes. Regrade and fill sinkholes.
54	35.2		Dry	Low	Not apparent	Stable	Regrade	C			Dress all surfaces.

TABLE 1: SUMMARY OF PIT OBSERVATIONS AND CLOSURE RECOMMENDATIONS

Site WP No.	Km Post	General Location Comments	Pit Water	Erosion Potential	Ground Ice Features	Active Layer Stability	Reclamation Focus	Priority	Ground Photos	Aerial Oblique Photos	Closure Comments
55	34.0		Minor ponding	Low	Minor wedge ice	Stable	Regrade	C	720		Regrade to fill wedge cracks and dress surface.
56	33.8R		Dry	Low	Not apparent	Stable	Regrade	C			Small square pit. Dress all surfaces.
57	33.5R		Partial	Low	Not apparent	Moderate	Partial infill and regrade	C			Three small pits, two dry and one with water. Regrade or import fill to flatten or berm embankment sideslope beside water-filled pit. Grade surface.
58	32.4R		Partial	Low	Not apparent	Moderate	Regrade	C	721		Pushup pit. Rough bottom. Grade surface, improve drainage. Defined pit on left about 300 m further south is dry and needs no work.
59	30.6R		Dry	Low	Not apparent	Stable	Dress surfaces	C			High, well-drained side borrow site. Dress bottom and slopes.
60	30.5R		Dry	Low	Not apparent	Stable	Dress surfaces	C			Similar to Site 59.
61	30.2R		Dry	Low	Not apparent	Stable	Dress surfaces	C			Similar to Sites 59 and 60.
62	29.1L		Minor ponding	Low	Not apparent		Regrade	C			Near vertical slope on sidehill pit. Slope pit back at 3H:1V and add some shoulder to road. Improve drainage.
63	27.5R		Minor ponding	Low	Not apparent	Stable	Regrade vertical slope	C	722		Pit has a near verticle slope 2 to 3 m high. Slope back to 3H:1V and dress pit bottom to improve drainage away from road embankment.
64	27.2L&R		Major ponding	Low	Not apparent	Stable	Regrade backslope, develop drainage plan	B		682	Deep pits on both road shoulders, both flooded. Slope sides to 3H:1V and develop a drainage plan. It may be practical to ditch to the creek about 100 m to the north.
65	26.3L&R		Minor	Low	Not apparent	Stable	Dress surfaces	C	723, 724		Pushup pits on both sides. Well drained. Dress slopes and ensure future drainage.
66	24.1L&R		Minor	Low	Not apparent	Stable	Dress surfaces	C			Pushup pits both sides. Currently self-draining to tundra. Not obvious erosion or sinkholes. Grade sideslope into pond lying to the left side.
67	23.7L		dry	Low	Not apparent	Stable	Dress surfaces	C			Well drained pit on top of natural rise. Dress bottom and slopes.
68	22.3R		Minor ponding	Low	Massive ice	Unstable	Fill and Cover Sinkholes	B	726, 727, 728	616	Melt out of massive ice actively developing sinkholes at toe of embankment sideslope. A berm should be built on sideslope and sinkholes infilled at 2 locations. Regrade to improve drainage to the northwest.
69	23.4R	Out of sequence — returned to inspect this site	Minor ponding	Moderate	Segregated ice	Unstable	Control drainage and limit sediment transport	C			Pit cut into side of knob. Thaw of icy soils is producing meltwater and sediment. Selective use of a boulder rip-rap blanket is recommended. Use rip-rap to control and filter drainage that is being dispersed onto tundra.
70	21.7L		Water-filled pothole pit beside road	Low	Unknown	Unstable	Water-filled pit	C		641	Pothole immediately beside embankment sideslope. Drain and install culvert under road. May require widening shoulder and partial infilling to maintain long-term drainage.
71	21.1R		Water-filled wedge cracks	Moderate	Substantial wedge ice	Unstable	Prevent further ice wedge thaw	B	729, 730	618, 617, 641	Active layer removed from top of hill, exposing substantial wedge ice. Substantial melt out and continued activity. Water collecting in wedge cracks. Develop drainage and fill expanding wedge cracks. Berm the sideslope to prevent further thaw under road embankment.
72	20.3L		Water-filled pit	Moderate	Unknown	Moderate	Develop pit drainage	B			A 2 m deep pit with water. No obvious opportunities to develop drainage. Survey and determine options to drain while minimizing further cuts. May require berming along road to prevent thaw from undercutting embankment sideslopes.
73	18.8R		Large water-filled pit	Moderate	Not apparent	Moderate	Develop pit drainage	B		619	Large pit pond immediately adjacent to road. Appears to be deep water. Currently no drainage. Can be drained by installing a culvert under the road. Flatten sideslopes into pit to push water further from road shoulder.
74	16.9L&R		Linear pits both sides with water	Moderate	Not apparent	Moderate	Develop pit drainage	B			Long, linear pits both sides. Left side has larger pond. No thaw features apparent. Assess drainage options. Flatten embankment sideslopes where water is at the toe of slope.
75	15.3R		Some water	Low	Not apparent	Stable	Dress surfaces	C			Long pit, some water, no active subsidence, dress surfaces.
76	14.5L		Dry	Low	Not apparent	Stable	Dress surfaces	C			Dry, well-drained pit floor. Stockpile of sandy gravel present. Dress surfaces.
77	13.8L		Pond	Low	Not apparent	Moderate	Pothole pit	C			Some refilling may be required in pothole pit beside road.
78	13.5L		One pond to north	Low	Not apparent	Moderate	Large area to dress	C		623	Shallow pit on top of rise. Pond in north end that can be drained to the north. Grade and dress surfaces.
79	13.1L&R		Wet bottom	Low	Segregated ice	Unstable	Large surface area	B		624	Pit in silty sand, abundant ground ice. Active thaw in pit floor. Surface will need to be regraded to cover exposed icy sediments. Several visits may be necessary to stabilize the new active layer.
80	10.0L		Water-filled wedge cracks	Low	Wedge ice	Unstable	Active sinkholes in wedge cracks	B	732, 733, 734	636	Extensive melt out of ice wedges resulting in water-filled troughs. Need to drain and fill sinkholes. Material should be imported as the entire pit is underlain by wedge ice and further removal of active layer material will exacerbate reclamation.
81	9.7R		Extensive pond	Moderate	Wedge ice	Unstable	Wedge cracks flooded in pit bottom	B		636	Flat bottom pit with no drainage. Develop drainage and fill wedge cracks evident below water level. Dress and grade surfaces.
82	9.4L`		Dry	Low	Segregated ice	Unstable	Sinkholes	C		635	Sidehill cut into bank beside road. Backfill and regrade with rip-rap quality material. Allow future drainage from cover.
83	8.0L&R		Left pit flooded, right pit wet	Moderate	Wedge ice	Unstable	Road shoulder unstable, develop drainage	B		634	Deep pits (about 3 m) no drainage. Ice wedge cracks and sinkholes. Backfill sinkholes and regrade steep slopes. Rebuild and flatten road sideslopes. Regrade base and improve drainage.
84	6.9R		Flooded	Moderate	Wedge ice	Moderate	Develop drainage	C		627	Broad flooded pit. Develop drainage. Grade and dress pond edges and road sideslopes.
85	3.8R	Milne Inlet permitted pit	Dry	Low	Minor wedge ice	Stable	Silty sand susceptible to dusting	B		630	This is the main permitted pit for development at Milne Inlet. The site is a dry and naturally well-drained river terrace. The material is fine grained (silty) and may be susceptible to generating dust. Small dune-like features evident on surface. If the site is retained for future use, a pit plan should be prepared. In order to control dust, it may be necessary to provide ridges of coarse material at closure that will trap wind-blown sand.
86	3.1R&L	Milne Inlet permitted pit	Minor pond on left, right is dry	Low	Not apparent	Stable	Regrade to protect from dusting	B			Small pits, silty sand poor construction material. Grade and work cover to provide a coarser cap.
87	2.9R	Within permit	Localized ponding	Low	Not apparent	Stable	Regrade to protect from dusting	B		631	Large exposed pit; silty sand may need a coarser cover to protect from dusting.
Return to MR Camp and check pit on mine road (88)											
88	104.4L	Mine road, above camp	Generally dry	Low	Not apparent	Stable	Develop a pit plan	C		667	Substantial volumes of reasonable quality material may remain in this pit. A pit development plan is recommended in order to keep it open. Reclamation will comprise regrading and control of runoff to ensure the stream to the north is not affected by runoff and deposition of silt or fine sand.

PHOTOGRAPHS

Photo 1
Priority B pit at km 97.9 (WP 9) just north of Mary River Camp lies on a gravel terrace with well established Ice Wedge polygons. Melt out within the pit has initiated thaw and ponding.

Photo 2
Pit at km 22.3 (WP 68) linear sinkhole from thaw of wedge ice about to affect road shoulder.

Photo 3
Road collapse at km 55.4 (WP 35) initiated by thermal erosion from water running through ice wedge exposed in adjacent pit.

Photo 4
Pit at km 71.8 (WP 23) typical sinkholes in pit bottom from thaw of segregated ice common in fine-grained lacustrine soils

Photo 5
Pit at km 63.7 (WP 29) exposure of massive ice remaining in pit wall.

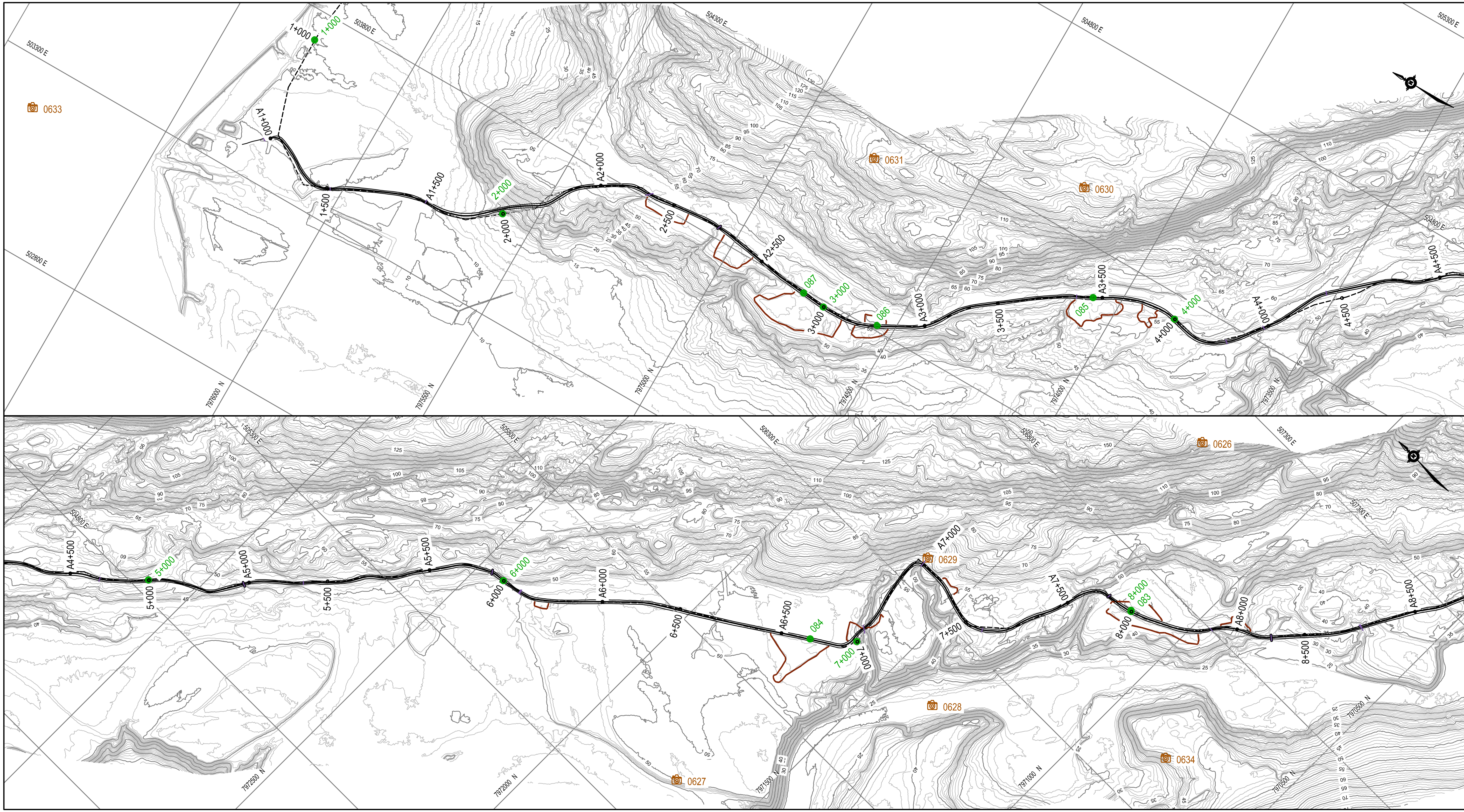
Photo 6
Pit at km 97.5 (WP 10) typical sinkhole formation from thaw of massive ice.

Photo 7
Pit at km 32.4 (WP 58) typical Priority C pit in thaw stable soils that only requires regrading.

Photo 8
Pit at km 27.5 (WP 63) vertical cut slope 2 to 3 m high. The thaw-stable soils at this site are stable at this slope. The slope can be graded back to 3:1 by cut and fill.

APPENDIX A

APPENDIX A MAP SET



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PLAN - PHOTO LOCATIONS
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Figure 1

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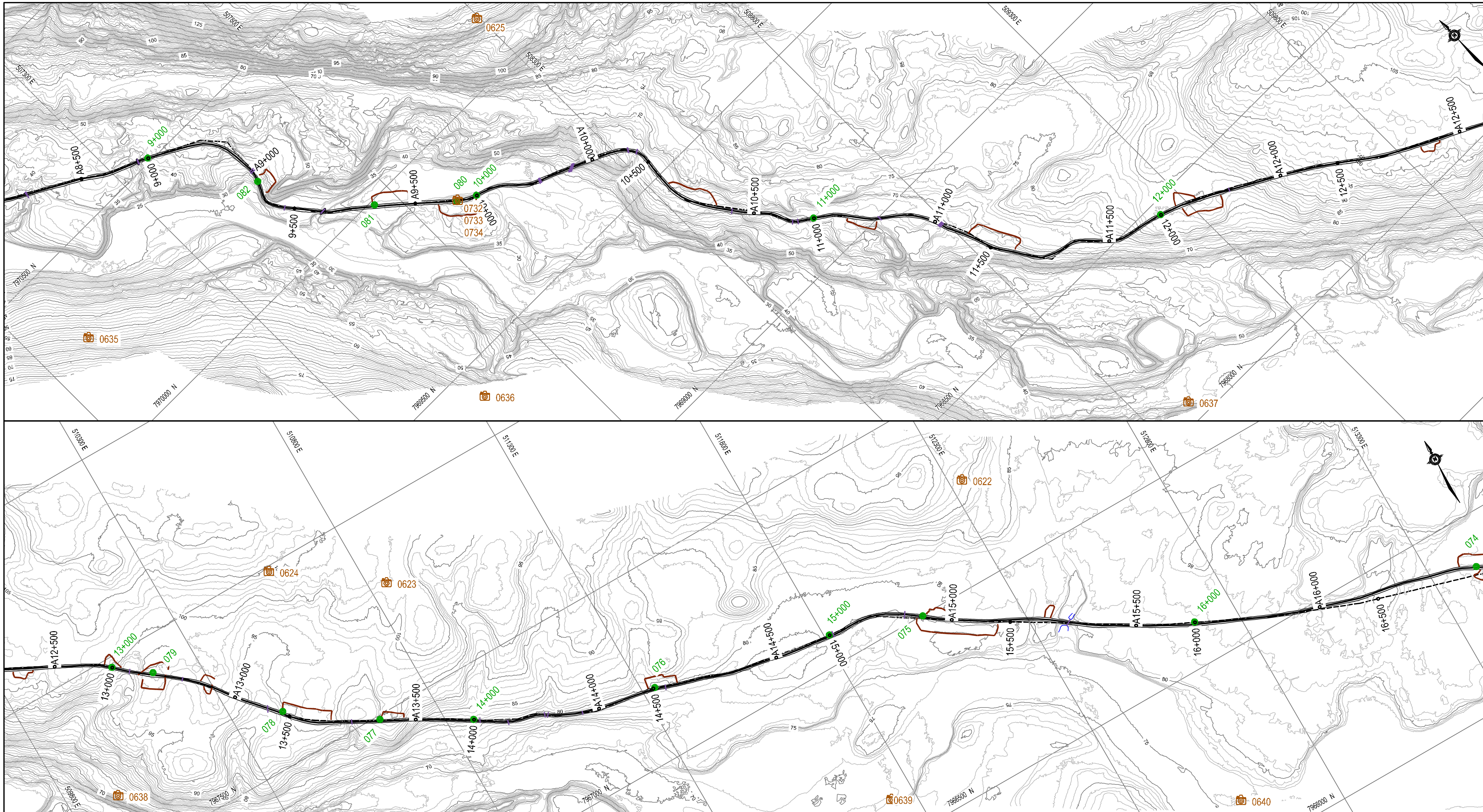

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Figure 2

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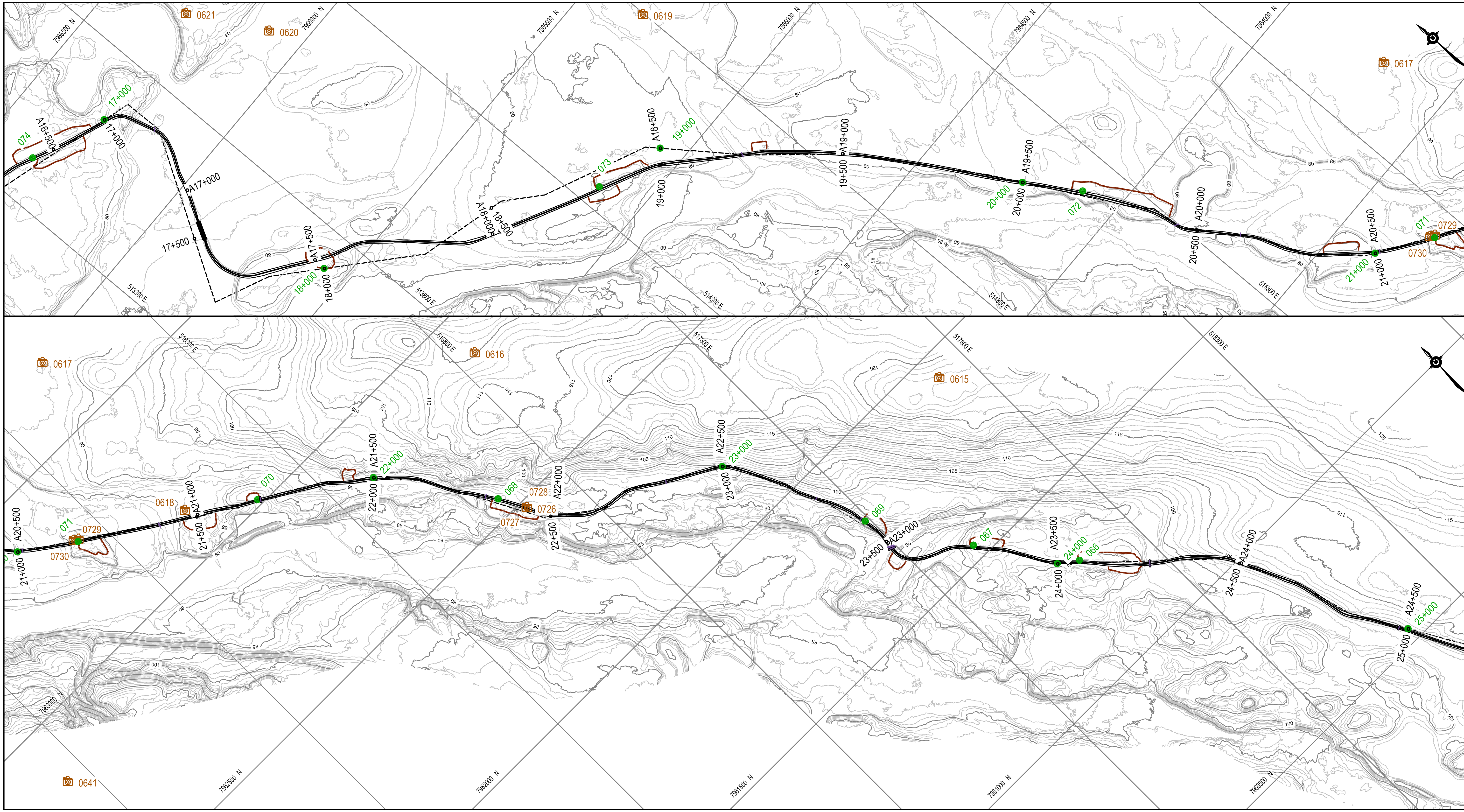

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Figure 3

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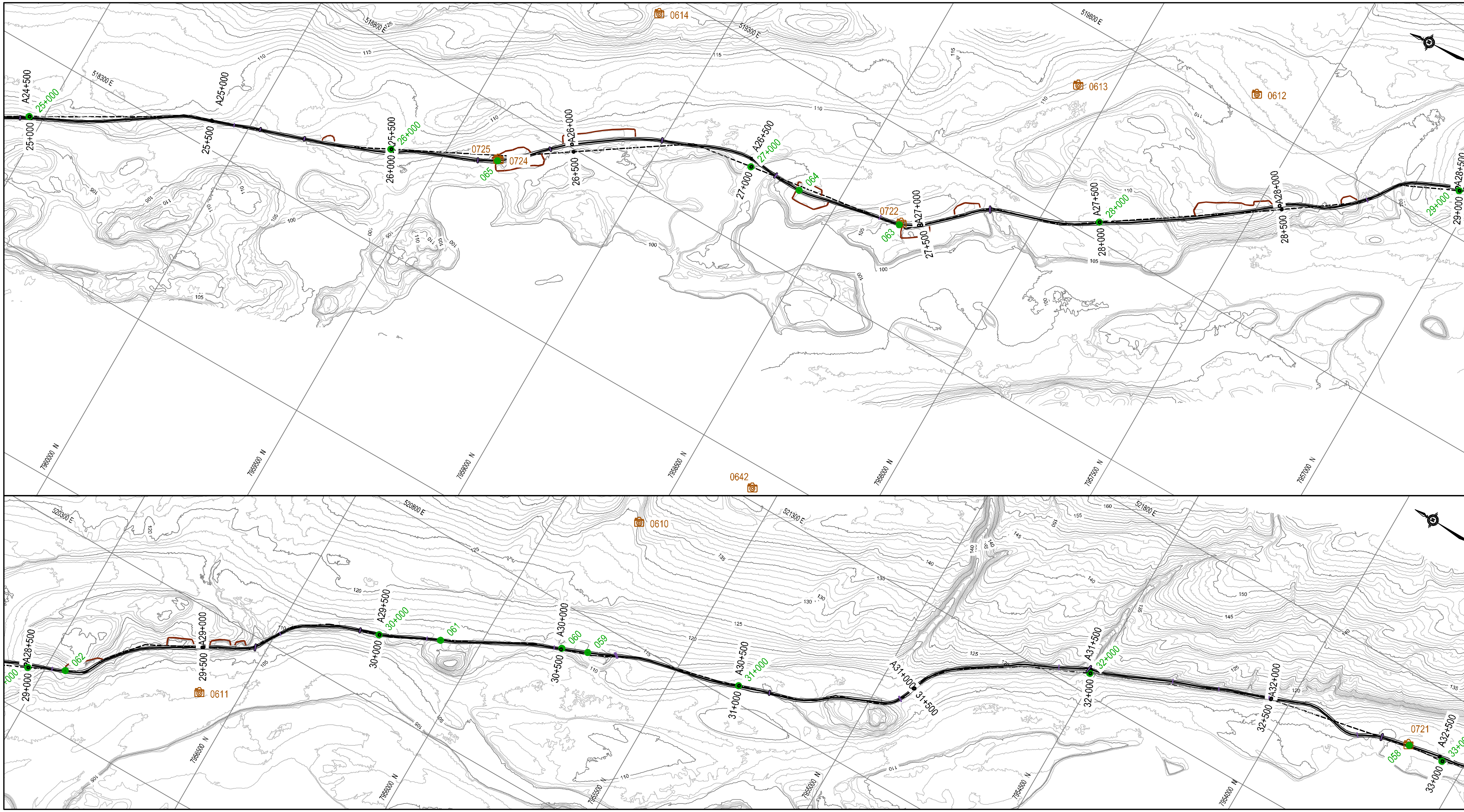

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Figure 4

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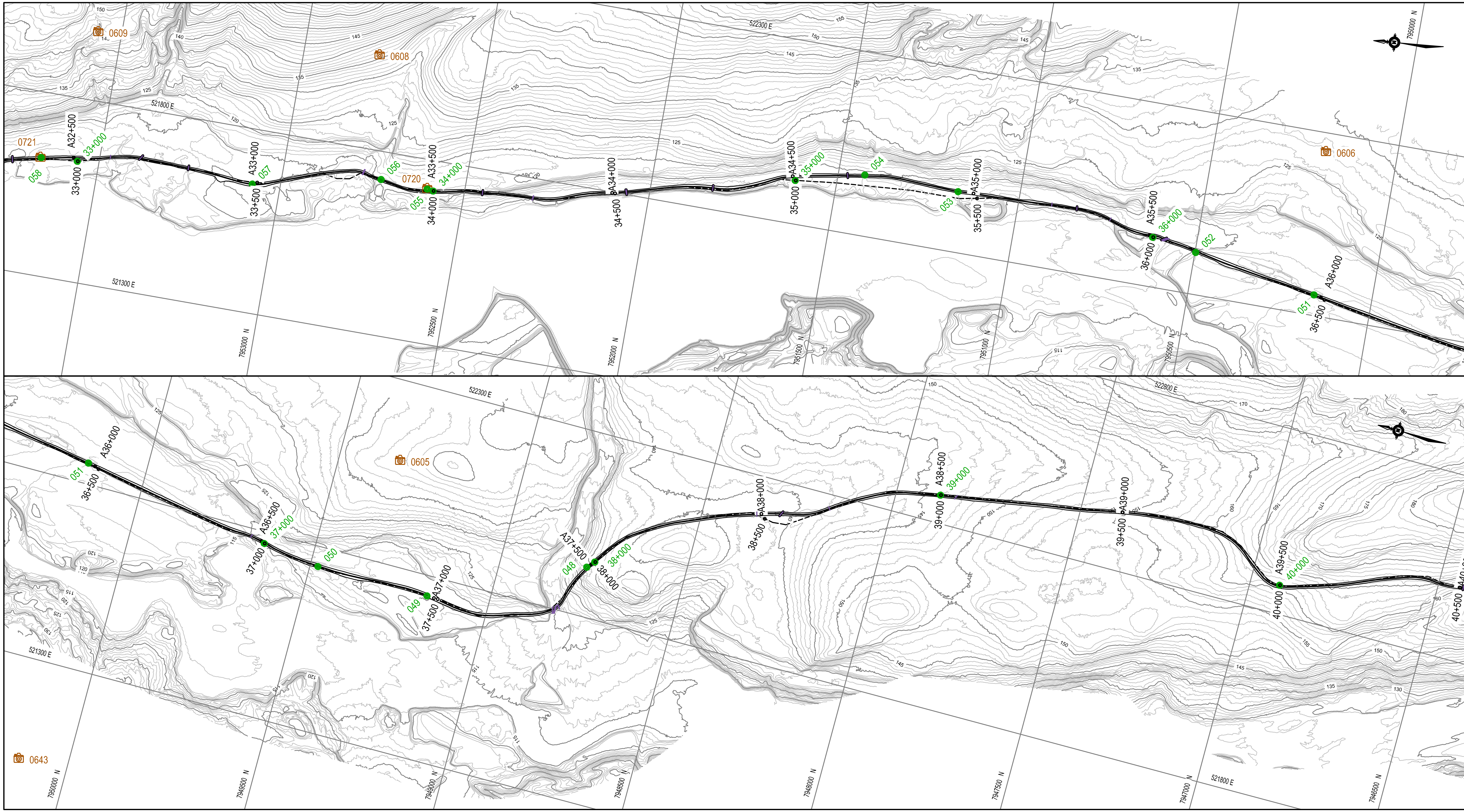

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Figure 5

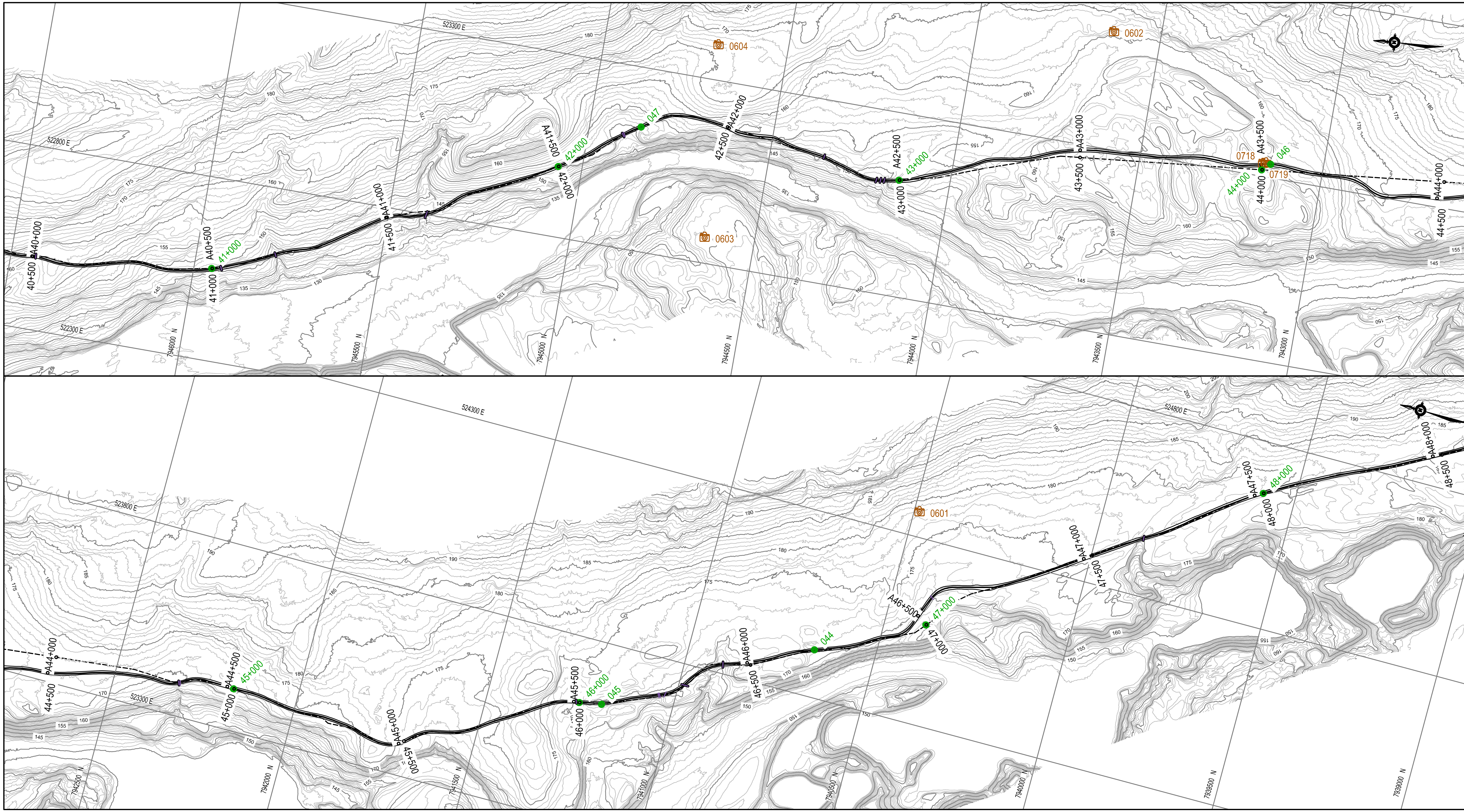

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Figure 6

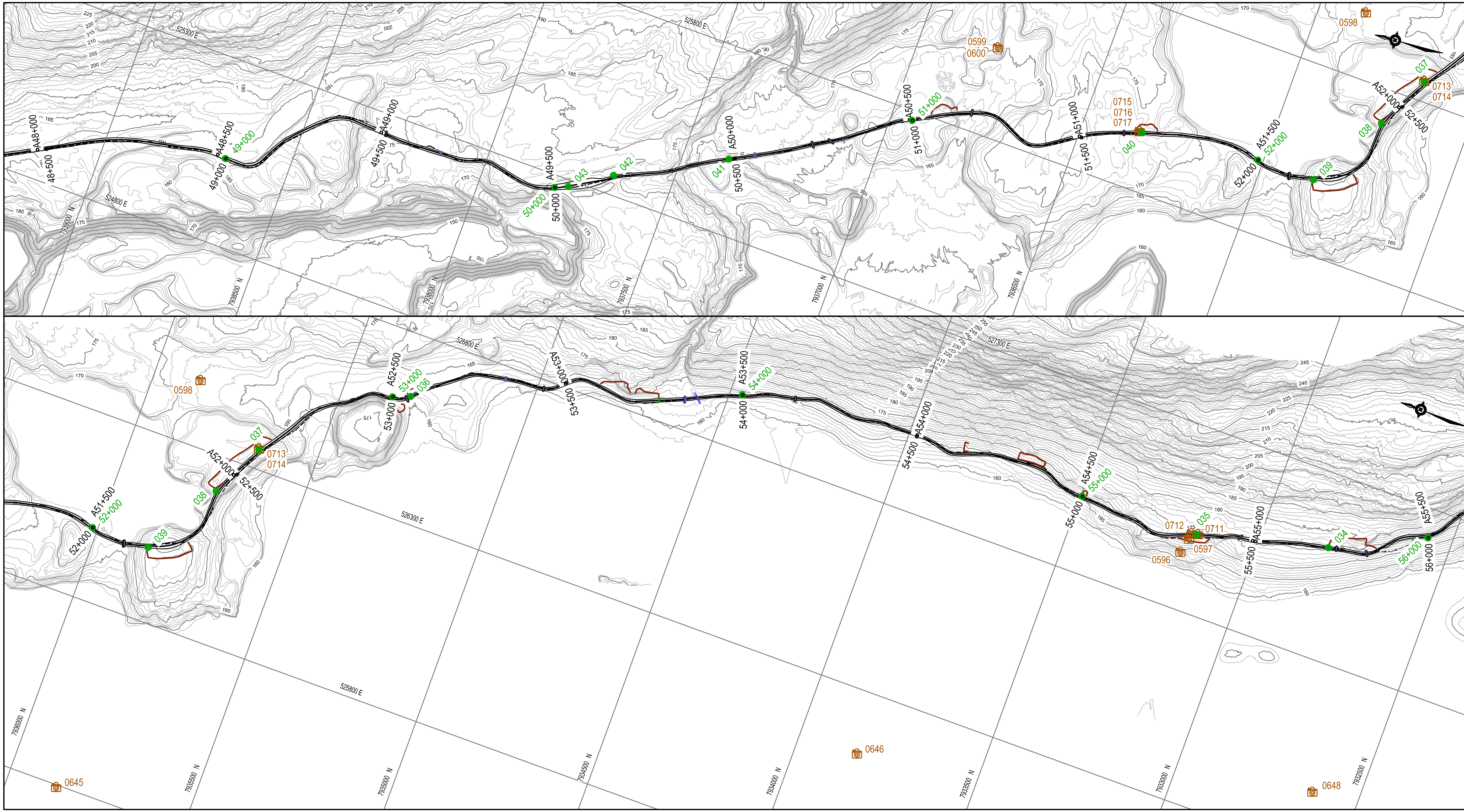

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Figure 7

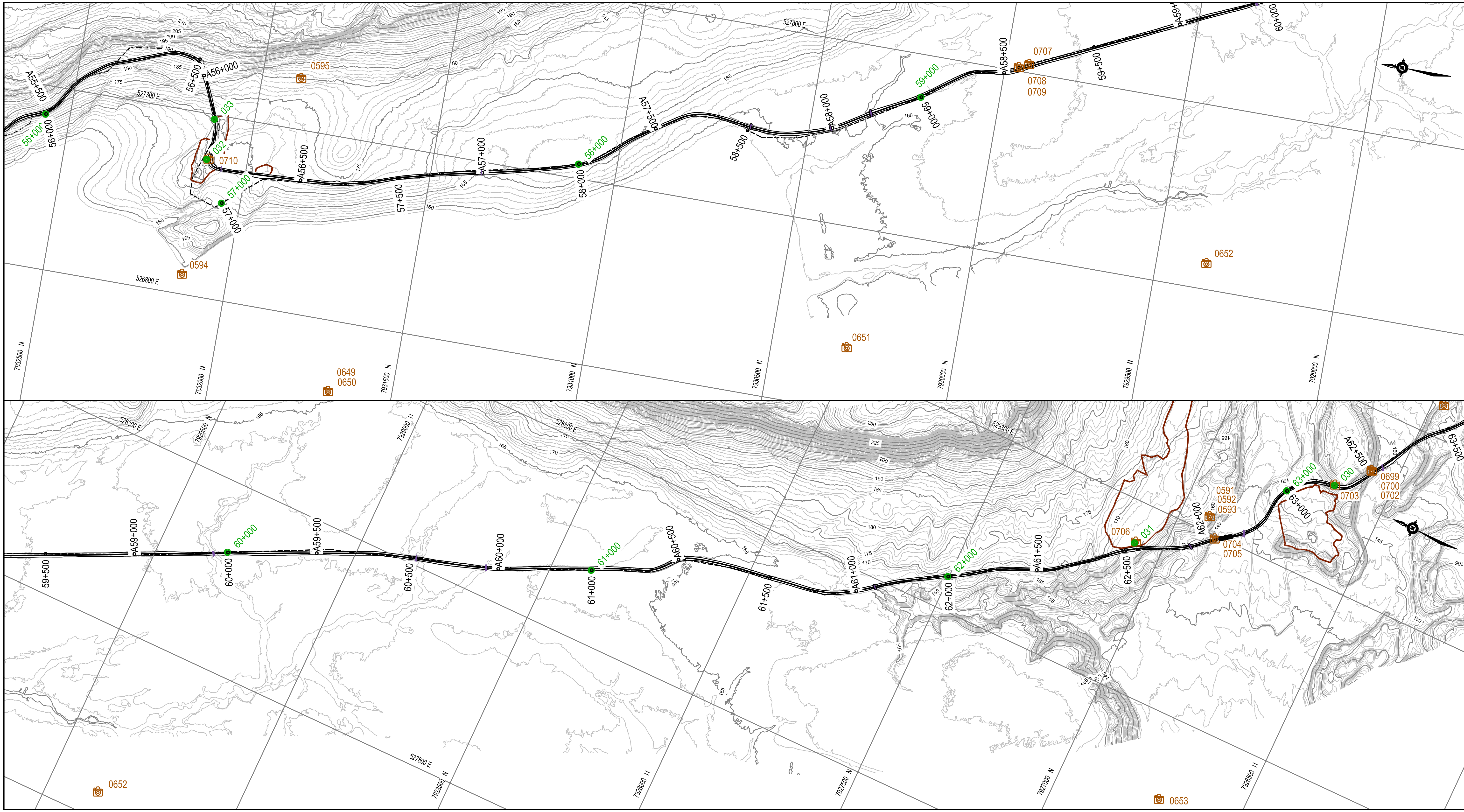

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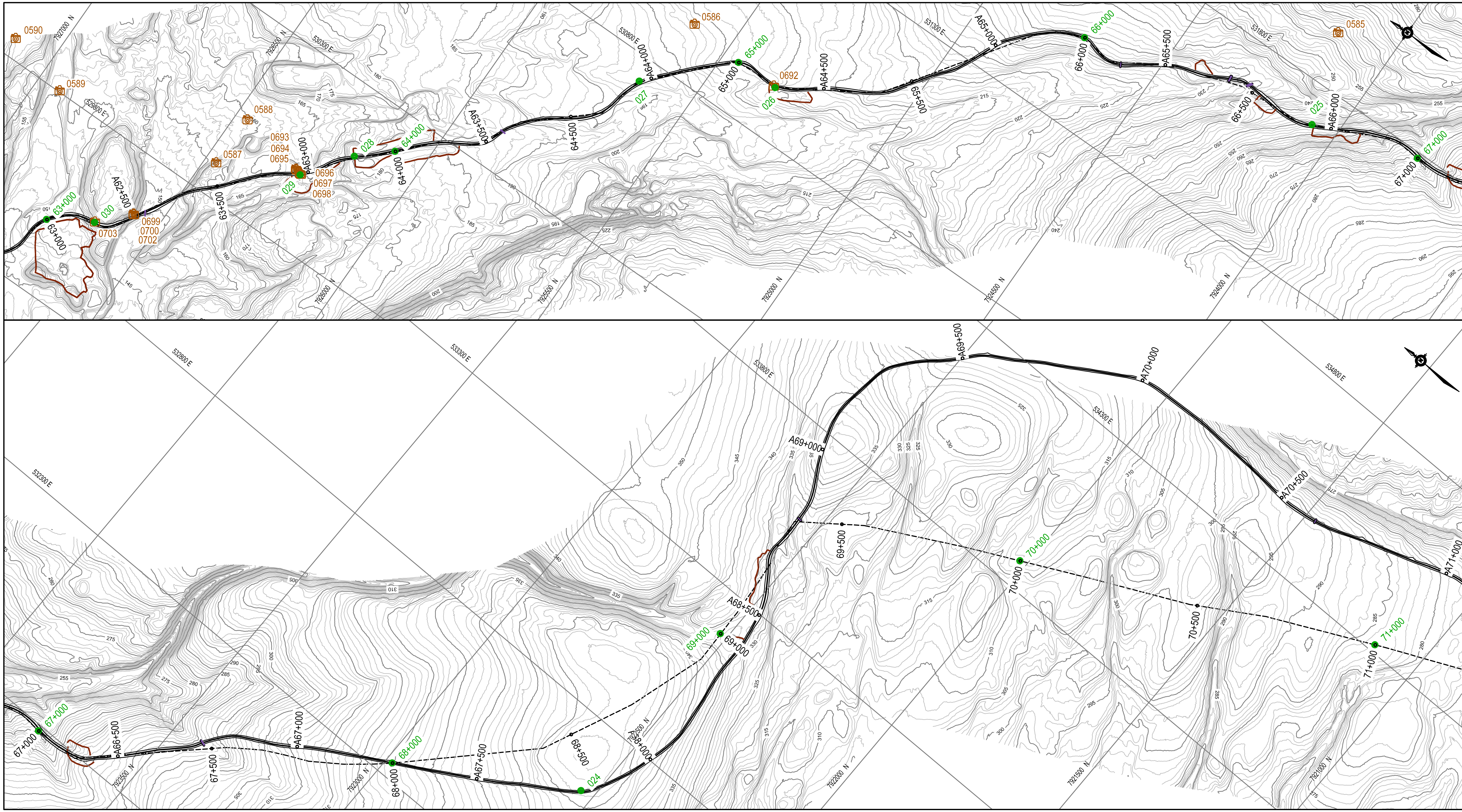
Figure 8



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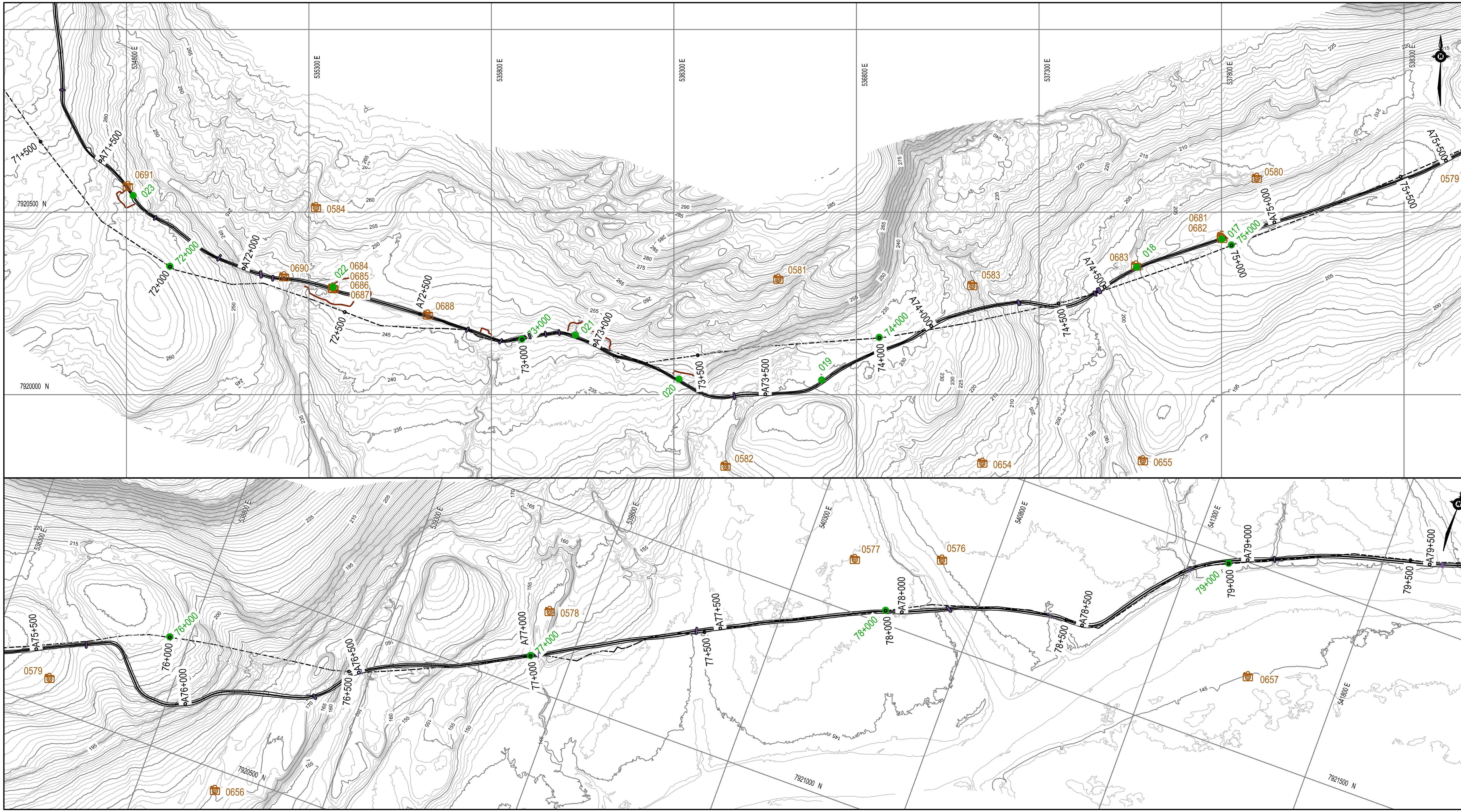
EDM	August 20, 2009		

Figure 9



LEGEND:

- PHOTOGRAPH LOCATION
- WAYPOINT LOCATION

NOTE:
BASED ON DRAWING DATA PROVIDED
BY KNIGHT PIESOLD CONSULTING

0 500
Scale: 1: 10 000 (metres)

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MARY RIVER TOTE ROAD QUARRY RECLAIMATION
MARY RIVER, BAFFIN ISLAND

PLAN - PHOTO LOCATIONS
SHEET 10 OF 14

PROJECT NO.	DWN	CKD	REV
E14101074	DRG	DH	0
OFFICE	DATE		
EDM	August 20, 2009		

Figure 10

Q:\Edmonton\Drafting\CIVIL3D\E141\E14101074\Civil 3D\E14101074_D01_R0_Photo Locations.DWG [FIGURE 11] August 25, 2009 - 6:43:41 pm (BY: DON GAMMIE)

LEGEND:

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- WAYPOINT LOCATION

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PLAN - PHOTO LOCATIONS
SHEET 11 OF 14

PROJECT NO.	DWN	CKD	REV
E14101074	DRG	DH	0
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EDM	August 20, 2009		

Figure 11

Q:\Edmonton\Drafting\CIVIL3D\E141\E14101074\Civil 3D\E14101074_D01_R0_Photo Locations.DWG [FIGURE 12] August 25, 2009 - 6:46:52 pm (BY: DON GAMMIE)

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PLAN - PHOTO LOCATIONS
SHEET 12 OF 14

PROJECT NO.	DWN	CKD	REV
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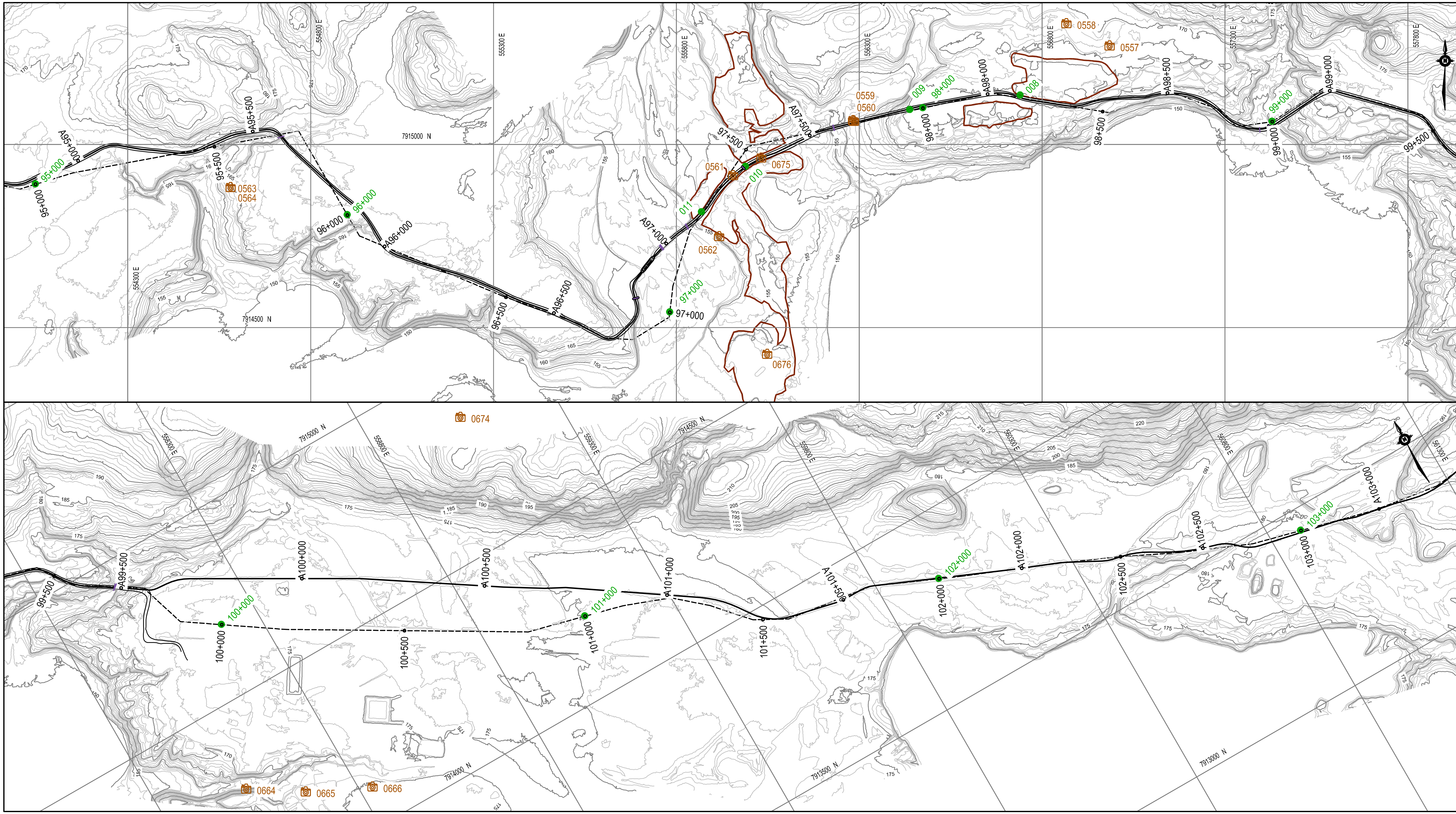
EDM	August 20, 2009		

Figure 12

Q:\Edmonton\Drafting\CIVIL3D\E141\E14101074\Civil 3D\E14101074_D01_R0_Photo Locations.DWG [FIGURE 13] August 25, 2009 - 6:50:25 pm (BY: DON GAMMIE)



LEGEND:

- PHOTOGRAPH LOCATION
- WAYPOINT LOCATION

NOTE:
BASED ON DRAWING DATA PROVIDED
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Scale: 1: 10 000 (metres)

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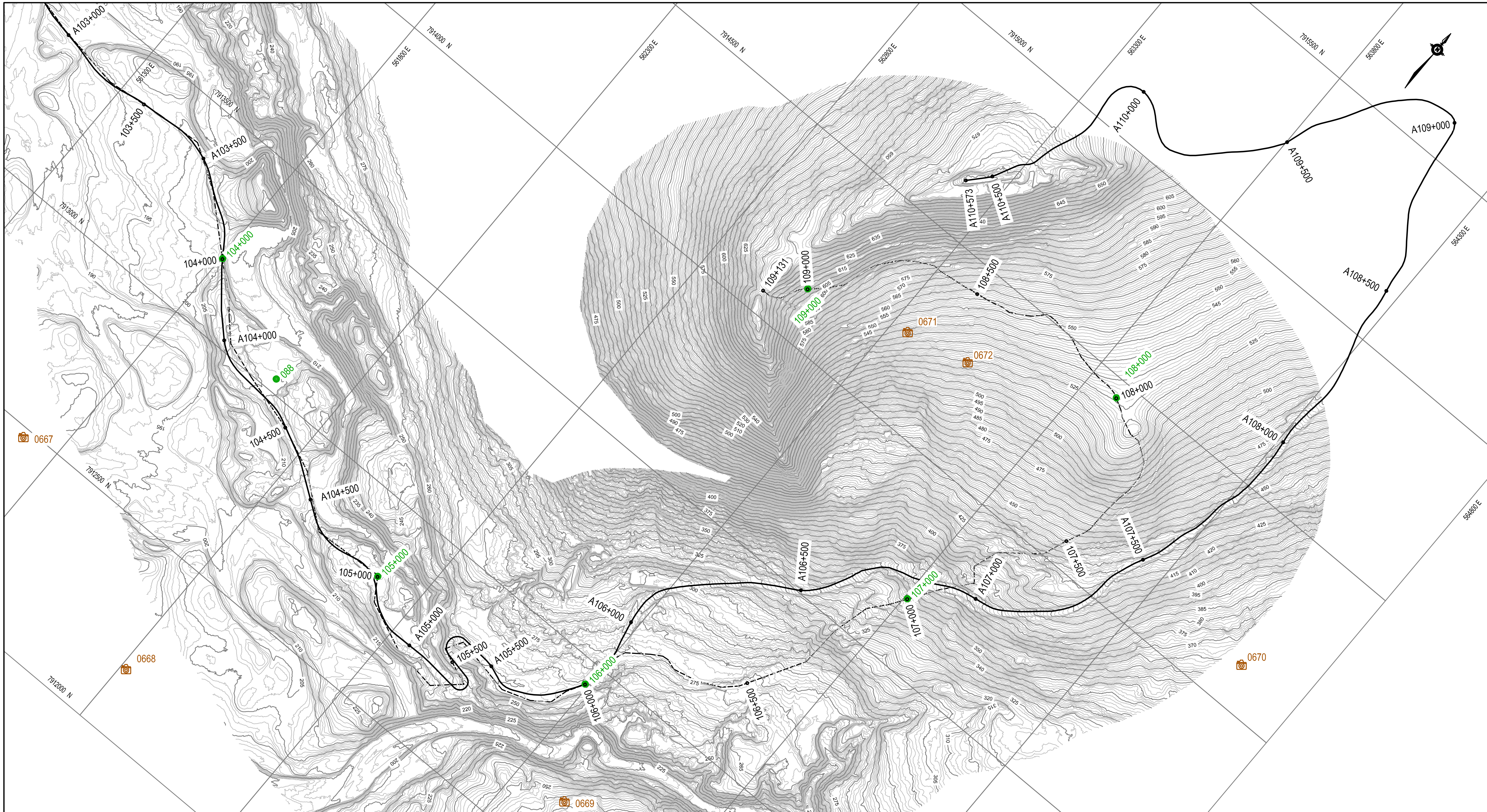
PLAN - PHOTO LOCATIONS
SHEET 13 OF 14

PROJECT NO.	DWN	CKD	REV
E14101074	DRG	DH	0
OFFICE	DATE		
EDM	August 20, 2009		

Figure 13

Q:\Edmonton\Drafting\CIVIL3D\E141\E14101074\Civil 3D\E14101074_D01_R0_Photo Locations.DWG [FIGURE 14] August 25, 2009 - 6:53:23 pm (BY: DON GAMMIE)



LEGEND:

- PHOTOGRAPH LOCATION
- WAYPOINT LOCATION

NOTE:
BASED ON DRAWING DATA PROVIDED
BY KNIGHT PIESOLD CONSULTING

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Scale: 1: 10 000 (metres)

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PLAN - PHOTO LOCATIONS
SHEET 14 OF 14

PROJECT NO.	DWN	CKD	REV
E14101074	DRG	DH	0
OFFICE	DATE		
EDM	August 20, 2009		

Figure 14

APPENDIX B

APPENDIX B PHOTOGRAPHS (DVD)

APPENDIX C

APPENDIX C GEOTECHNICAL REPORT GENERAL CONDITIONS

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgemental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

9.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

10.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

11.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

12.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

13.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

14.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.