



McElhanney
Since 1910



ASSOCIATION OF CONSULTING
ENGINEERING COMPANIES | CANADA



McElhanney

Since 1910

PORT MANN / HIGHWAY 1 IMPROVEMENT DETOURS – Commuters' Lifeline

ACEC Awards 2013



05
municipalities

17
highway interchanges

300+
km of HOV lanes

700+
km of detour lanes

5,000+
drawings

6,000+
detour signs

80,000
person-hours

Port Mann / Highway 1 Improvement Detours – Commuters' Lifeline
ACEC Awards 2013



Table of Contents

CONFIRMATION RECEIPT	I
ENTRY CONSENT FORM.....	IV
PORT MANN / HIGHWAY 1 IMPROVEMENT DETOURS - COMMUTERS' LIFELINE	1
Introduction	1
Objectives, Solutions and Achievements.....	2
i. Objectives	2
ii. Solutions.....	3
iii. Achievements	3
Complexities and Challenges.....	4
Technical Excellence and Innovation	4
i. Customized Use of Temporary Raised Pavement Markers.....	4
ii. A Standard for Temporary Freeway Construction Access	5
iii. Left-Turn On/Off Ramps	5
Schedule and Budget.....	6
Project Management.....	6
Environmental Impact.....	7
Social and Economic Benefits.....	7
Exceeding Owner's and Client's Expectations	8



The map shows the detour route for the Port Mann / Highway 1 Improvement Project. It starts at McGill St in Vancouver, marked with a yellow dot and the word 'START'. The route follows Highway 1, passing through the Cape Horn Interchange, which is highlighted with a yellow box and a text box stating: 'The Cape Horn Interchange, the largest and busiest interchange in BC, required a complex sequence of more than 30 detours.' The route continues through several more yellow dots and ends at 208 St in Langley, marked with a yellow dot and the word 'END'. The route is shown in orange with yellow dots at key locations. The background is an aerial view of the region.

PORT MANN / HIGHWAY 1 IMPROVEMENT DETOURS - Commuters' Lifeline

Submitted by McElhanney Consulting Services Ltd.

INTRODUCTION

The \$3.3B Port Mann / Highway 1 (PMH1) Improvement Project is the largest design-build transportation infrastructure project in the history of Canada. This is a key component of the greater Gateway Program in British Columbia, established in 2006, to improve the movement of people, goods and transit throughout Metro Vancouver to support continuing growth expected in the region.

The PMH1 Project replaced the 50 year old Port Mann Bridge with the world's widest long-span 10-lane bridge, implemented 37 km of highway widening spanning five municipalities from Vancouver to Langley and 17 highway interchange upgrades. It also incorporated Transit and High Occupancy Vehicle (HOV) usage ramps and multi-use structures for cyclists and pedestrian access.

Transportation Investment Corporation (TI Corp) is the public crown corporation established to implement and deliver this massive project which is the major corridor for flow of goods and people that directly contributes to the local economy. TI Corp must ensure that over 120,000 vehicles continue to travel this route daily and safely to avoid paralyzing the economy. The detours component of the project, serving as a lifeline to commuters during construction, was assigned to McElhanney Engineering Services Ltd. (McElhanney) as Prime Consultant by the Design-Build Contractor, Kiewit/Flatiron General Partnership (Kiewit/Flatiron).

For 5 years to December 2012, McElhanney spent just under 40 person-years or 80,000 person-hours to develop timely and comprehensive detour plans for Highway 1 and connecting roadways. The Team produced in excess of 300 individually customized detour plans over 700 km of detour lanes to move people and goods during the construction of permanent structures.

Although Detours are temporary, the engineering principles and techniques applied in every design are no less rigorous than permanent structures since they still have to be functional and safe, regardless of duration of use. The 'glam and glitz' of the new Port Mann Bridge far overshadow the diligence and innovation of the men and women who have been orchestrating safe and effective traffic re-routing behind the scenes to advance the overall Project. The Detours Project was recognized as Project of the Year by the Institute of Transportation Engineers, Greater Vancouver Chapter, in November 2012.



200th Street Interchange,
Langley, BC

The PMH1 Detour Design Project presents the ultimate challenge with its magnitude, performance period, challenging environment, and urgency to accommodate the construction of permanent structures. The Design Team exceeded project performance criteria by providing detour solutions meeting concurrent milestones, to ultimately advance the success of the main PMH1 Project and the overall Gateway Program. Despite complex and extensive detours that would normally increase risks, it was also reported that collision rates in fact decreased over the duration of the project.

OBJECTIVES, SOLUTIONS AND ACHIEVEMENTS

TI Corp, in conjunction with the BC Ministry of Transportation and Infrastructure (MoTI), established key objectives in its Requests for Qualifications and Proposals documents, as well as the subsequent Design-Build Agreement with Kiewit/ Flatiron. McElhanney was responsible for implementing these objectives as they pertained to detours.

I. OBJECTIVES

In accordance with the overall goals of the PMH1 Project, detour designs were required to address specific issues including:

- Safety: Maintain or improve the safety of motorists, cyclists, pedestrians and construction workers;
- High Speed Flow: Maintain free-flow, high-speed traffic conditions on Highway 1;
- HOV, Transit & Multi-Modal: Accommodate high-occupancy and commercial vehicles, ensure uninterrupted transit service and maintain multi-modal transportation;



HOV, Commercial, Transit
and Multi-modal users are
accommodated on the Port
Mann Bridge

- Minimal Disruption: Facilitate complex construction staging with minimal phases; and
- Minimize Waste: Minimize temporary construction to reduce throw-away.

In collaboration with TI Corp and Kiewit/Flatiron, McElhanney developed a systematic approach to optimize performance and accelerate deliverables to achieve goals and milestones of the Project.

II. SOLUTIONS

McElhanney was instrumental in developing detour strategies that responded to site-specific needs, while meeting stringent design criteria and specifications considered the most comprehensive of any BC MoTI project.

Careful planning was crucial to maintain a safe driving environment that met or exceeded the typical highway design standards expected by motorists. No concessions were permitted where safety was concerned. Safety reviews were incorporated in all internal quality control measures, from detour design to construction to traffic management. Independent safety audits were conducted after each detour implementation.

Detour designs needed to be clear and logical, with proper signage and pavement markings. Effective and timely communication with the public was paramount to improve adaptability and predictability. Advance signage, detour notifications and construction bulletins were issued promptly via the project website and other media.

When full highway closures were required, way-finding signage was carefully designed to divert traffic away from and back to Highway 1. Whenever possible, work was completed in the late evening or overnight, with a return to full service levels in time for the morning commute. For longer term traffic diversion, where secondary roadways were impacted by additional traffic volume, McElhanney analyzed resulting traffic patterns to determine capacity and required level of improvements, such as adjusting existing signal timing plans, signal coordination, or installing temporary traffic signals.

Detour design accommodated all modes of transportation in a safe and efficient manner. Consideration was made for transit on connecting arterial roads such as Lougheed Highway and United Boulevard, and commercial vehicle access was maintained at the truck scales on Highway 1 between 160th Street and 176th Street in Surrey. Custom signs were developed to safely guide pedestrians and cyclists along temporary routes to maintain existing networks, and through many of the project's 17 major interchanges.

McElhanney worked closely with Kiewit/Flatiron throughout the detour design process to minimize the number of construction stages, limit rework and throw-away; while allowing construction staging to proceed in an efficient, safe and cost-effective manner. This resulted in an accelerated construction schedule with minimal disruption to traffic.

III. ACHIEVEMENTS

McElhanney produced massive quantities of comprehensive detour plans for the entire route and connecting roadways. Each detour set of plans required unique geometric design, traffic analysis, drainage design, signage and pavement markings. These complexities, coupled with unyielding location constraints, constant public scrutiny and tight timelines, required the Detours Team to be highly versatile and innovative. They developed new standards for temporary raised pavement markers, custom signage, freeway construction access and unconventional left-turn on/off ramps while meeting current MoTI standard specifications for highway construction.

All designs met the project's stringent detour specifications, considered the most comprehensive of any BC MoTI construction project. Consideration was given for ultimate design configurations to minimize throw-away while meeting environmental goals and achieving cost savings, and for overall construction schedules.

COMPLEXITIES AND CHALLENGES

Detour designs, construction and implementation on a high-speed main artery used by more than 120,000 vehicles each day present extensive design and traffic management challenges. Detours are constrained by limited right-of-way, existing structures including utilities, rail lines and environmentally sensitive areas and must make room for permanent structures. The extent of the route required complex staging with multiple detour sequences, often requiring overlapping design elements such as geometric features, pavement markings and guide signage. McElhanney led the design quality reviews to ensure integration of the overall design. Detours also required coordination between the West (Vancouver and Burnaby), Central (Coquitlam) and East (Surrey and Langley) project segments along Highway 1, to provide a seamless transition with adjacent segment.

One of the most challenging sections of the project was the Cape Horn Interchange at the west end of the Port Mann Bridge. Situated at the convergence point of three highways, the Cape Horn was the largest and busiest interchange in BC and required an intricate sequence of more than 30 detours to maintain traffic flow.

Cape Horn Interchange – Coquitlam, BC



TECHNICAL EXCELLENCE AND INNOVATION

For 5 years ending December 2012, McElhanney's Detours Team spent 40 person-years or 80,000 person-hours to effectively implement over 300 detour designs, representing over 700 km of detour lanes, 5,000 drawings and 6,000 detour signs. These designs required solid engineering and construction knowledge, backed by meticulous attention to detail, adaptability, innovation and creativity.

The uniqueness of existing constraints at each detour site frequently required customized geometric and drainage designs, with specific signage and pavement markings. To continually achieve project objectives in a cost effective and timely manner, the Team developed innovative amendments to existing standards and guidelines for conventional detour designs. Some of the innovations include:

I. CUSTOMIZED USE OF TEMPORARY RAISED PAVEMENT MARKERS

McElhanney introduced the use of temporary Raised Pavement Markers (RPMs) on permanent roadways as a significant number of detour alignments were designed for the ultimate design surface, requiring temporary pavement markings on the final lift of pavement. The RPMs and reflective tape were used instead of conventional painted lane lines because the latter would leave undesirable pavement scarring and a ghosting effect on the surface of the pavement or final concrete bridge deck surfaces.

McElhanney researched using temporary RPMs and reflective tape to develop a new standard on the PMH1 Project. A pilot project was undertaken on a kilometre test section. A safety audit by an independent road safety auditor concluded that using RPMs provided improved guidance for motorists. Its effectiveness was further enhanced by developing arrows, HOV symbols and gore standards using temporary RPMs. The highly successful use of RPMs reduced overall project costs while avoiding damage to completed road surfaces.

II. A STANDARD FOR TEMPORARY FREEWAY CONSTRUCTION ACCESS

The project required construction within the existing median and shoulder areas of Highway 1. Temporary accesses for slow-moving construction vehicles were therefore required to expedite construction activities safely without impeding the 80 km/h freeway traffic. With no existing design standards or guidelines for freeway construction-only accesses, McElhanney developed an innovative standard that can also be used in future projects.



Construction Activities in Median and Shoulder

III. LEFT-TURN ON/OFF RAMPS



152nd Street Interchange, Surrey, BC

With the temporary nature of detours, budgetary considerations are keenly observed with uncompromised safety standards. It was determined that left-turn on/off ramps at the 152nd Street Interchange would eliminate the need for a temporary overpass structure and corresponding construction stages, saving the project millions of dollars. Although left-turn on/off ramps have been used on freeways in the United States, all were permanent applications and no literature existed on temporary usage. The process would require temporarily educating and re-educating motorists, which could have adverse safety implications.

MoTI was previously reluctant to deviate from its policy of only right-turn on/off ramps with concerns over potential traffic operation and safety issues. McElhanney carefully researched the use of this application in other jurisdictions and applied the findings to the detour design at 152nd Street Interchange and recommended significant public notification. The constructed detour configuration operated successfully and safely. McElhanney's design resulted in a new baseline standard for future left-turn on/off ramp treatments in the province, saving time and effort.

SCHEDULE AND BUDGET

McElhanney's timely delivery of detour designs enabled Kiewit/Flatiron to reach substantial completion for all major project segments required for tolling commencement as early as December 2012, including the official opening of eight lanes of traffic on the new Port Mann Bridge.

McElhanney achieved time and cost savings by considering overall construction schedules and ultimate design configurations when planning detours. Throw-away work was minimized, reducing materials wastage. In some cases, many unnecessary detour stages and temporary infrastructure were eliminated altogether due to the proactive and innovative applications used by the Team.

PROJECT MANAGEMENT

McElhanney performed a significant project management role on the PMH1 Project, including coordination and design of detour geometry, guide signage, pavement markings, drainage, and construction accesses. McElhanney also played a major role in receiving approvals from TI Corp, MoTI, and adjacent municipalities. Obtaining laning approvals, traffic analysis acceptance by municipalities to determine level of service and staging were key to the success of the Project.

The design and approval process was always completed under tight project timelines, with as little as two weeks to meet fluctuating construction initiation deadlines.

To ensure continual and efficient communications between all parties, McElhanney's Project Team and TI Corp were co-located at Kiewit/Flatiron project site office. This arrangement enabled complex designs to be reviewed more efficiently with the Contractor, frequently resulting in immediate feedback for amendments or acceptance. The ongoing collaboration with the design-build contractor was a key factor contributing to the accelerated detour designs.

To meet the demands of this fast-paced construction project, McElhanney was able to quickly assemble a highly qualified team of specialists, comprising up to 25 staff members at any given time, including engineers, technologists, CADD operators and support staff. McElhanney drew on the professional expertise of staff in the areas of project management, design management, geometric design, highway design, traffic engineering, signage, drainage design, road safety and quality control. Its in-house Quality Management System, recently certified under ISO 9001:2008, was applied in the preparation of each detour submission package to ensure high-quality end results. Using in-house orthophoto expertise, McElhanney developed geometric detour designs directly on up-to-date site images to prove-out design compatibility with existing surface features.



Geometric Detour Design Over Orthophoto to Prove-out Design Compatibility

ENVIRONMENTAL IMPACT

The PMH1 Project promotes carpool and transit use through extended HOV lanes and new dedicated transit ramps, thus reducing congestion, idling vehicles and carbon emissions. Some 15 km of new HOV lanes are being added on the Project. Transit will be reliably accommodated on Highway 1 for the first time in over 25 years. To promote a reduction in vehicle usage, the project features new multi-use paths, including new cyclist and pedestrian connections across the new Port Mann Bridge.



The new Bridge opened in December 2012 while detours were still being implemented over 16 km of Highway 1 through Coquitlam, Burnaby and Vancouver. As transit was an integral part of the final PMH1 Project delivery, McElhanney's forward looking Team produced detour designs from the onset to accommodate the new bus routes not only on the freeway but also at all the interchanges where detours were under full implementation.

Detour designs achieved environmental benefits by maintaining high-speed, free-flow traffic to reduce vehicle emissions. Traffic slowdowns were minimized through smooth accesses and transitions, complying with strict delay limits along Highway 1. Similarly, connecting roadways, roadway approaches and municipal intersections affected by the Project were evaluated to minimize slow-downs and subsequent idling.

Minimizing throw-away costs and materials in the detour designs became an environmentally friendly residual of the innovative approach by McElhanney.

SOCIAL AND ECONOMIC BENEFITS

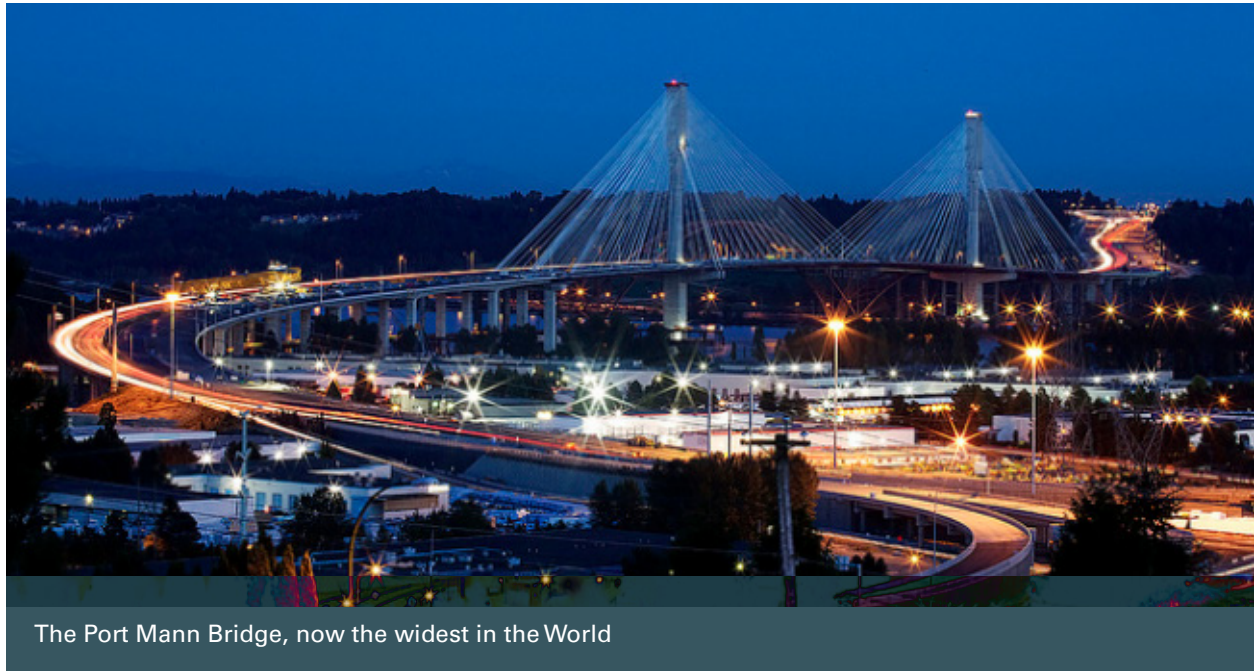
It is well established and documented that strategic infrastructure investments stimulate the economy which is critical to maintaining current standard of living and quality of life of its people, as well as generating future economic and social opportunities. An infrastructure project of this magnitude has undoubtedly resulted in substantial benefits to the BC economy as evidenced by growth in local employment and consumer spending, which mitigated the effects of the global slowdown experienced in recent years. The benefits also rippled through other industries and economies as labour and materials were sourced to support the Project.

In addition, all costs are expected to be recovered by electronic tolls which meant that available federal or provincial funding could be applied to other more pressing priorities and transit improvements to further improve the lives of all taxpayers and the economy.

As a lifeline for commuters during the construction phase of the main PMH1 Project, all detours, though temporary in nature, contribute to maintain local economic activity through connectivity of communities in the region. McElhanney's comprehensive detour designs enabled this major project to be constructed and delivered seamlessly, with minimal impact on end users. Unlike traditional projects, free-flow traffic has been maintained during all aspects of construction, limiting disruption and delays.

Final project delivery will have a significant impact on the quality of life for regular users of Highway 1. Travel times will decrease by up to 30%, saving commuters up to an hour each way during rush hour traffic. As part of the Trans-Canada Highway that connects Canada's east and west coasts, Highway 1 serves as a gateway for commercial and tourist activity in this region.

Although detours are implemented and decommissioned during project construction of the PMH1 Project, its overall effectiveness and success were essential to the opening of the new Port Mann Bridge, to earn its place in the Guinness Book of World Records as the widest bridge in the world.



EXCEEDING OWNER'S AND CLIENT'S EXPECTATIONS

Detour design is a very complex sub-specialty of transportation engineering, with no textbook answers to the issues and challenges presented. Each detour was unique and required meticulous attention to detail, solid engineering experience and excellent judgement. The engineering on this project exemplifies the nature of the profession to constantly go beyond conventional approaches and to test, prove and adopt new innovations to reach new heights in the discipline. The success achieved illustrates the engineer's ability to adapt, innovate and solve problems in a complex and challenging environment, while under intense and often critical public scrutiny.

McElhanney's in-house orthophoto expertise augmented the design process to prove-out design functionality with existing site features. Forward planning resulted in detour designs that accommodated HOV, commercial, transit service and multi-modal transportation, ahead of final delivery of the permanent structures.

The Engineers and Technical personnel on the Detours Team were presented the Bill Curtis Project of the Year Award, by the Greater Vancouver Chapter of the Institute of Transportation Engineers, in November 2012.